OCS Study
MMS 90-00”

Ecological Research Associates

USE OF KASEGALUK LAGOON, CHUKCHI SEA, ALASKA BY MARINE BIRDS AND MAMMALS

Draft Report of 1989-1990 Studies

by

LGL Alaska Research Associates, Inc.
4175 Tudor Centre Drive, Suite 101
Anchorage, Alaska 99508-5917

and

Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska 99701

for

U.S. Minerals Management Service
Procurement Operations
381 Elden St., MS635
Herndon, VA 2207--4817

Contract 14-35-0002-30491
LGL Report TA863-2

March 1991

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This study was funded by the Alaska Outer Continental Shelf Region of the Minerals Management Service, U.S. Dept. of Interior, Anchorage, AK, under contract 14-12-0001-30491.

PROJECT AND REPORT ORGANIZATION

This contract was conducted by LGL Alaska Research Associates, Inc., Anchorage, Alaska, in cooperation with the following organizations: Alaska Department of Fish and Game (ADFG), Fairbanks, Alaska; North Slope Borough Department of Wildlife Management, Barrow, Alaska; Golden Plover Air, Inc., Colville Village, Alaska. LGL conducted the bird studies, and ADFG, in conjunction with the North Slope Borough (in 1989), conducted the marine mammal studies. Golden Plover Air provided the Cessna 206 aircraft, pilot, and logistics support associated with the aircraft.

The contract award for this project was 25 July 1989 and project initiation was 8 August 1989, too late for some aspects of the proposed study to commence according to the schedule proposed by MMS. The beluga whale (Delphinapterus leucas) surveys that were to commence in early July 1989, and at least one bird survey to be conducted in late July or early August 1989 were deferred until 1991. Thus, this report includes information on only one season (1990) of beluga surveys and only one full season (1990) of bird and seal surveys.

Except for the beluga whale surveys in early July 1990, logistics were coordinated so that bird and mammal surveys were conducted during the same time-periods using the same aircraft, pilot, and field accomodations in 1989 and 1990. Nevertheless, many aspects of the two parts of this study involved different data collection procedures with emphasis on different parts of the study area.

Marine mammal studies were focused on the beluga whale migration and on spotted seal (Phoca largha) haulout locations. The beluga migration occurs over a broad area in both nearshore and offshore waters adjacent to the study area in the first half of July. Spotted seals rested at specific haulout sites in Kasegaluk Lagoon from late-July until freeze-up. Most of the mammal surveys were reconnaissance flights over offshore marine areas to detect, count and classify belugas, or they were surveillance flights over specific shoreline haulout locations to count spotted seals. Bird studies, on the other hand, were over a broader range of mixed aquatic and terrestrial habitats in and immediately adjacent to Kasegaluk Lagoon. There were no bird surveys conducted in offshore regions of the Chukchi Sea.

As a consequence of these differences in project organization and procedures, this report is divided into two sections. Part I deals with birds and incidental sightings of marine and terrestrial mammals recorded during bird surveys. Part II deals exclusively with marine mammals.

PART I

PART I

MARINE BIRD USE OF THE KASEGALUK LAGOON AREA, CHUKCHI SEA, ALASKA

Draft Report of 1989-1990 Studies

by

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ABSTRACT

The purpose of this study was to determine the distribution, abundance, and habitat use by marine birds and mammals in the Kasegaluk Lagoon area, Chukchi Sea, Alaska. This part of the report (PART I) describes the results of the bird studies. Our study involved a review of relevant information from other investigations of barrier island-lagoon systems in Arctic Alaska and a series of systematic aerial surveys of representative habitats in the Kasegaluk Lagoon system. The aerial surveys were conducted from 24 August to 11 September 1989 (5 surveys) and from 27 July to 10 September 1990 (8 surveys). Although the duration and intensity of sampling were different in the two years, sufficient information was collected to determine patterns of bird use in the Kasegaluk Lagoon system and to compare these uses with other similar lagoon systems in Arctic Alaska. Overall, the key bird species using Kasegaluk Lagoon were similar to those recorded in other Arctic Alaskan systems, with the major exception that the black brant, rather than the oldsquaw duck, was the dominant species in Kasegaluk Lagoon. In fact, 45% and 15% of the estimated total Pacific Flyway populations of brant were recorded in the study area in 1989 and 1990, respectively. Brant staged in Kasegaluk Lagoon, mostly in the northeast section of the lagoon, apparently to feed (mainly on the marine algae Ulva) prior to resuming their southward migration. Oldsquaw were far less abundant and glaucous gulls and arctic terns were far more abundant in Kasegaluk Lagoon compared to other Arctic Alaskan barrier island lagoon systems, Birds tended to prefer lagoon margin habitats in both years of study; about 25% of all bird sightings in both years were seen along the lagoon-barrier island margin. Only two species, the oldsquaw duck and the arctic tern, showed a preference for the passes connecting the lagoon with the nearshore Chukchi Sea. Shorebirds showed a strong preference for mudflat habitats. Both the richness and diversity of bird species using Kasegaluk Lagoon are greater than in similar lagoon systems in the Beaufort Sea. The species richness and species diversity indices computed for the Kasegaluk Lagoon area (48 and 0.844, respectively) and the Peard Bay-Franklin Spit area (37 and 0.772, respectively) were over 100% greater than those computed for similar Beaufort Sea lagoon systems (29 and 0.174, respectively). In the Beaufort Sea one species, the oldsquaw duck, has made up over 90% of all bird sightings during lo-years of surveys. The overwhelming dominance by a single species in Beaufort Sea lagoon systems is reflected in the low species richness and low species diversity indices for this area — 29 and 0.174, respectively, for Central Beaufort Sea lagoons, and 24 and 0.342, respectively, for 11 ANWR lagoons). In conclusion, based on current information from the literature and from two years of aerial surveys, we are not able to refute the research hypothesis presented at the outset of this study: ***"Kasegaluk Lagoon supports special habitat uses by vertebrates, uses that are not duplicated in lagoon habitats elsewhere in the Alaskan Arctic."***

ACKNOWLEDGEMENTS

We appreciate the help and advice of the residents of Point Lay, Alaska. In particular, Warren Neakok, Amos Agnasagga, Willie Tookruk, and Bill Tracey provided logistics support and advised on community matters important to our study. Andy Fields, principal of Cully School, Point Lay, helped in a number of ways and we appreciated his hospitality.

We worked closely with the Alaska Department of Fish and Game (ADFG) and the North Slope Borough (NSB) on this project. It was a pleasure to work with Kathy Frost and Lloyd Lowry (ADFG), Geoff Carroll (NSB then ADFG), and Robert Suydam (NSB). Our special thanks to Kathy Frost for arranging important logistics and providing important liaison with the community of Point Lay.

Steve Treaty, Jerry Imm, Bob Meyers, and Bill Chambers of MMS provided guidance and advice on various contractual, logistics, and data-related matters. Rolph Davis of LGL provided important administrative guidance throughout this project.

We especially thank our pilot, Jim Helmericks and his family at Colville Village, whose friendship, patience, cooperation, and logistics support were critical in conducting this investigation. Bruce Di Labio, Derek Helmericks, and Ron Rideout helped with the aerial surveys and coding of survey data. Gary Searing and Chris Holdsworth assisted with data entry and validation. Shirley Brown, Lisa Clarke and Alison Hedge helped in the final production of this report.

INTRODUCTION

This study was designed to determine the use of the Kasegaluk Lagoon system in the northeastern Chukchi Sea (Fig. 1) by birds and mammals. Several Inupiaq Eskimo communities, e.g., Point Lay and Wainwright, for example are located along this section of the Chukchi Sea coast of Arctic Alaska. Residents of these communities use local marine bird and mammal resources for subsistence. In 1989 and 1990 oil and gas wells were drilled on leases in the Chukchi Sea offshore from the Kasegaluk Lagoon area; this area is likely to be the focus of petroleum exploration and development activities for many years. As a consequence, there has been a need for more information on the temporal and spatial distribution and abundance of mammals and birds in and adjacent to the Kasegaluk Lagoon area.

Background

About 100 species of birds have been recorded in various marine and terrestrial habitats in the Kasegaluk Lagoon region (Roseneau and Herter 1984). Of these 100 species, only 13-15 are relatively common. In particular, three species or species groups of waterfowl — geese such as black brant (Branta bernicla nigracans) and greater white-fronted geese (Anser albifrons frontals), eiders (S. mollissima v-nigra and Somateria spectabilis) and oldsquaw (Clangula hyemalis) are known to use habitats in and adjacent to Kasegaluk Lagoon for nesting (eiders), molting (eiders and oldsquaw), and feeding (all species). Several of these waterfowl are important in local and national economies: thousands of eiders (and a few oldsquaws) are harvested by subsistence hunters throughout the Bering-Chukchi-Beaufort region, and thousands of black brant and greater white-fronted geese are harvested by hunters along the Pacific Flyway in Western North America.

Of about 40 species of shorebirds known to occur in the region, only six — red and red-necked phalaropes (Phalaropus fulicarius and P. lobatus, respectively), pectoral sandpiper (Calidris melanotos), dunlin (C. alpina), western sandpiper (C. mauri) and sernipalmated sandpiper (C. pusilla) — are common in tundra nesting habitats, in barrier island-lagoon habitats, or adjacent coastal marsh habitats. In addition, Pacific and red-throated loons (Gavia pacifica, G. stellata), black guillemot (Cepphus grylle) and glaucous gull

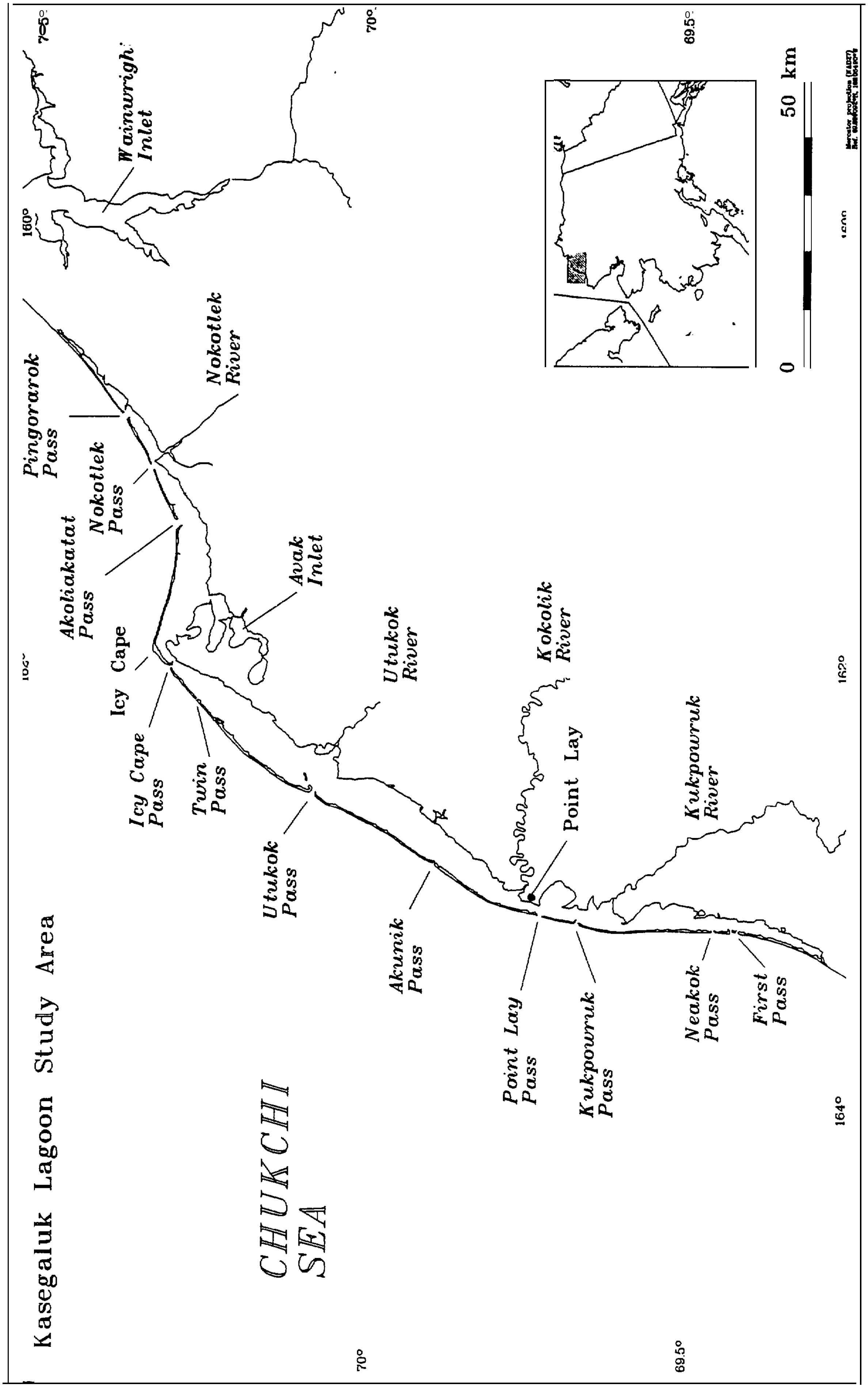


Figure 1. Kasegaluk Lagoon study area, Chukchi Sea, Alaska.

(Larus hyporboreus) use habitats in and adjacent to Kasegaluk Lagoon for feeding and/or nesting (Roseneau and Herter 1984).

Before this study began we speculated that bird use of Kasegaluk Lagoon may be quite similar to that of other Arctic lagoons that have been studied in Alaska. Information in the literature indicated that the oldsquaw, eiders, glaucous gull and phalaropes were the dominant bird species during most of the open water season in Kasegaluk Lagoon, a situation that is very similar to other lagoons along the Arctic coast of Alaska. Possible exceptions to this generality were the presumed larger numbers and higher densities of common eiders in the Kasegaluk Lagoon area. Several thousand black brant were also reported to pass through the Kasegaluk Lagoon area during fall migration (Lehnhausen and Quinlan 1982). Some of these species, such as the oldsquaws and some of the eiders, reportedly arrive in mid- to late summer (late-July through August) to feed and molt (Lehnhausen and Quinlan 1982; Roseneau and Herter 1984; Gill et al. 1985). It was reported that eiders aggregated in lagoon habitats, especially near the passes linking lagoons with the nearshore Chukchi Sea, and that geese may concentrate in marsh habitats along the mainland shoreline of the lagoon (Roseneau and Herter 1984).

Based on this historical information, Table 1 describes the expected relative abundances, habitat types used and periods of occupancy of birds in the Kasegaluk Lagoon area. The four dominant species or species groups of birds suspected to be present in the Kasegaluk Lagoon system during the spring through fall open-water period were (1) brant, (2) eiders, (3) oldsquaws and (4) shorebirds (Lehnhausen and Quinlan 1982; Roseneau and Herter 1984).

Objectives

The overall objective of this study was to determine the uses by birds of the Kasegaluk Lagoon area. There was sufficient information in the literature from previous work in Kasegaluk Lagoon, Peard Bay and other lagoons studied to indicate that Kasegaluk Lagoon is generally similar in form and function to other lagoons, such as Simpson Lagoon and lagoon farther east in the Alaskan Arctic. At the same time, it was suspected that there were some distinct characteristics of the Kasegaluk Lagoon, as follows:

Table 1. Estimated relative abundance, habitat use and period of occupancy of birds in the Kasegaluk Lagoon area, Chukchi Sea, Alaska (after Roseneau and Herter 1984).

Species	Est. Abundance	Habitat	Period of Occupancy
Brant	1,000-10,000	Salt Marsh/Lagoon	Mid August - September
Oldsquaw	2-6 birds/sq km	Tundra	June
	12,000-20,000	Island/Lagoon	July - late August
Eiders			
Common	2,000-3,000	Islands	Mid June - late July
Corn./King	1,000-3,000	Passes in Islands	Mid July - late August
Phalaropes			
Red	37/sq km	Wet Tundra	June
	100/km	Beaches	August - September
Red-necked	13/sq km	Wet Tundra	June
Calidris Spp.	7- 20/sq km	Tundra	June
C. alpina	287/sq km	Salt Marsh	August - mid September
c. mauri	170/sq km	Salt Marsh	August - mid September
C. pusilla	53/sq km	Salt Marsh	August - mid September
Glaucous Gull	1-3/km	Island	June - late July
	10- 100/km	Island - Lagoon	August - September
Arctic Tern	100-1,000	Island	June - July
	25- 100/sq km	Lagoon	June - July

1) The Alaska Coastal Current flowing into the Chukchi Sea from the Bering Sea may influence ecological processes in the Kasegaluk Lagoon area.

2) The passes leading into Kasegaluk Lagoon may attract many species of vertebrates (marine mammals, birds, fish), and these areas maybe of speaalimportance in this arctic lagoon system; such large concentrations of vertebrates at passes are not typical of Beaufort Sea lagoons.

3) Much of Kasegaluk Lagoon, especially the southern portion, appears to be quite shallow (< 1 m) and may not support key species of vertebrates to the same extent as deeper lagoons elsewhere.

4) Unlike the situation in most Beaufort Sea lagoons, temperature and salinity regimes in the Kasegaluk Lagoon system appear to be greatly influenced by periodic heavy rainfall in the western De Long Mountains and resultant increased discharges from the Utokok, Kokolik and other rivers that feed into the lagoon. These changes in temperature and salinity probably influence the distribution of invertebrates and perhaps some of their vertebrate predators (e.g., birds and marine mammals).

Research Hypothesis

Our approach to this study included heavy reliance on existing relevant information coupled with a focused program of research on the key species of birds in the lagoon system. The study was structured to test the following general hypothesis:

Ho: Kasegaluk Lagoon supports special habitat uses (alternatively, typical habitat uses) by vertebrates, uses that are not duplicated (alternatively, are duplicated) in lagoon habitats elsewhere in the Alaskan Arctic.

To test the above hypothesis we carried out a study that involved (1) a review of information (and reanalysis of some data) concerning bird use of the Kasegaluk Lagoon area, the Peard Bay-Franklin Spit area, and lagoons in the Alaskan Beaufort sea, and (2) an aerial survey program that quantitatively sampled various regions and major habitats in and adjacent to Kasegaluk Lagoon.

1) We conducted a review of all published and unpublished information on the distribution, relative abundance and habitat use of waterfowl, seabirds and shorebirds in and near Kasegaluk Lagoon and other Alaskan arctic lagoons.

2) We systematically surveyed by fixed-wing aircraft a set of transects established in various habitats in and adjacent to Kasegaluk Lagoon. The placement of the transects and timing and extent of the surveys was largely based on known habitat uses by birds in the Kasegaluk Lagoon area.

STUDY AREA

Kasegaluk Lagoon is situated along the Chukchi Sea coast of Alaska about 300 km SW of Point Barrow, Alaska (Fig. 1). The lagoon extends from about 69°16' N, 163°18' W in the southwest to about 70°30' N, 160°25' W in the northeast. Icy Cape, located at 70°20' N, 161°51 W, is a prominent coastal feature situated about two-thirds of the way north along the outer coast of Kasegaluk Lagoon. In total, the lagoon is about 200 km long — 135 km from the extreme southwest end to Icy Cape, and 65 km from Icy Cape to the extreme northeast end. The rolling foothills of the De Long Mountains are immediately adjacent to the southern end of Kasegaluk Lagoon. Farther north, virtually the entire mainland shoreline of the lagoon is backed by low tundra bluffs; vertical relief along these bluffs varies from near sea-level in river deltas and creek mouths to nearly 10 m along some sections at the north end of the study area.

Five major rivers or inlets drain into Kasegaluk Lagoon: the Nokotlek River and Avak Inlet flow into the northern part of the lagoon, and the Utukok River, Kokolik River, and Kukpowruk River drain into the southern part of the lagoon. Several well vegetated islands with high vertical relief are present in the deltas of the Utukok River and the Kukpowruk rivers. Most of these islands are covered with tundra vegetation, have extensive lakes and ponds, and are separated from the mainland by river channels and mudflats.

Barrier islands of silt, sand, and gravel shelter the entire length of Kasegaluk Lagoon except where passes allow an exchange of water between the lagoon system and the Chukchi Sea. In total 11 sets of passes breach the barrier islands, eight southwest of Icy Cape and three northeast of Icy Cape (Fig. 1). The largest passes (i.e., those that appear to allow the greatest exchange of water) are Utukok Pass, located southwest of Icy Cape, and Akoliakatat Pass, Nokotlek Pass, and Pingorarok Pass, all located northeast of Icy Cape (Fig. 1).

Barrier islands and shoals on the lagoonward sides of the islands are generally devoid of vegetation except for the region south of Utokok Pass. Barrier islands in this region, and especially in the region south of Kukpowruk Pass are low and subject to flooding during periods of high water. Such periodic flooding has created extensive marshes with small lakes, ponds and luxuriant vegetation on these sections of the barrier islands. Islands and portions of islands farther north support far less vegetation, with the exception of the shoals and small islets adjacent to the barrier islands 5-10 km north of Point Lay. These islets have extensive patches of lyme grass (*Elymus* spp.) and other vegetation unidentifiable from the aircraft.

Kasegaluk Lagoon varies considerably in width and depth (Nat. Ocean Survey Charts 16086, 16087, 16088, 16101, and 16102). Although bathymetric data are incomplete for a large part of the lagoon, especially the portion between Point Lay and Icy Cape, the northeastern portion of the lagoon (northeast of Icy Cape) is generally deeper (3-4 m in many places) and appears to be more saline (clear marine water visible from the aircraft) than the area to the southwest of Icy Cape. The northeastern portion is no wider than 8 km at its widest point off the mouth of Avak Inlet. Southwest of Icy Cape the lagoon is shallow (generally less than 2 m), turbid, and no wider than 10 km at its widest point off the mouth of the Utukok River. The most southwesterly part of the lagoon (i.e., the area southwest of the Kukpowruk River delta) is very shallow — only a few centimeters deep in many areas.

The influence of lunar tides is relatively inconsequential in the Kasegaluk Lagoon area — daily fluctuations are generally less than 15 cm. Winds, however, appear to play a very important role in regulating water-levels in Kasegaluk Lagoon. Winds from the north or east tend to drive water out of the lagoons, thereby causing water levels to fall. Winds from the south or west tend to drive water into the lagoons, causing water levels to rise. Sustained winds may cause water levels to rise or fall to extreme levels. Extensive areas of mudflats may be exposed in the shallow southern part of the lagoon (e.g., south of the Kukpowruk River delta) and in the shallow area around Icy Cape when sustained winds prevail from the north or northeast. In contrast, water levels may rise nearly 1 m or more in these same areas when sustained strong winds blow from the south or southwest. During periods when lagoons are filling, extensive plumes of clear marine water may be visible as intrusions into the lagoon. Conversely, during periods when lagoons are draining, extensive plumes of turbid lagoon water may be visible flowing into the nearshore marine system. Water levels may change considerably from one day to the next.

Seaward of the barrier islands water depths increase to 10 m within about 2 km of shore. The exception is Blossom Shoals at Icy Cape where water as shallow as 5 m extends seaward at least 5 km. Bottom substrates are composed of beds of gravel along most of this section of the Chukchi Sea coast, especially south of Point Lay and the area northeast of Icy Cape (Lewbel 1984).

Kasegaluk Lagoon is ice-covered for about 7 months — from early November through late May or early June. The nearby Chukchi Sea freezes in late November, and in some years ice may remain in the Blossom Shoals-Icy Cape area until early July.

Habitats in the study area are of four general types; mainland shoreline, mid-lagoon, barrier island, and nearshore marine. The mainland shoreline habitats consist of coastal tundra interspersed with ponds, lakes, streams, rivers and river deltas. The lagoon margin of the mainland shoreline consists of a sand or mud beach. During low-water periods this habitat is continuous with adjacent mud and sand flats. Mid-lagoon habitats are relatively uniform throughout the stud y area. Except for the shallow areas east of Icy Cape, and the area at the extreme southern end of the study area, both of which are exposed during low water, this habitat consists exclusively of lagoon waters. As described above, barrier island habitats consist mainly of sand and gravel beaches and beach ridges with little vegetation cover except for the southern sections of the barrier islands (i.e., mostly south of Point Lay). In the north, most of the barrier island chain and adjacent lagoon-side shorelines are devoid of vegetation and consist of gravel, sand and mud beaches, shoals, spits and islets. The passes connecting the lagoon with the Chukchi Sea are major features of this habitat type. Nearshore marine habitats are relatively uniform along the entire length of the study area except for the areas adjacent to the passes and the Blossom Shoals area adjacent to Icy Cape.

METHODS

Aerial Surveys of Birds

Design Considerations

The Request for Proposal for this study called for aerial surveys of "broad-area systematic transects employing sufficient initial randomization to permit density extrapolations among geographic sectors, environmental zones, or known distributional strata". This approach would involve subdivision of the study area into blocks of relatively homogeneous habitat within which transects could be established. In large areas, the series of transects to be surveyed could be randomly selected from some or all of the blocks. Such a stratified random approach is straightforward and is the easiest and most appropriate type of survey design for large areas or in the absence of information on the temporal and spatial distribution of the animals to be surveyed. In Kasegaluk Lagoon, however, it was suspected that the key bird species used very specific longitudinal habitats that would not be sampled well by random methods.

Other than the nearshore Chukchi Sea waters seaward of the barrier islands, it was thought that there would be little homogeneous habitat in the Kasegaluk Lagoon area. By definition a lagoon is an estuary or interface between terrestrial and marine ecosystems, and habitats are usually represented as gradients of relatively similar conditions as one moves away from the terrestrial system toward the marine system. Certain spots, such as river deltas and passes between barrier islands, interrupt lagoonal gradients because they are point sources of change, e.g., freshwater discharges or marine intrusions. In general, based on knowledge of the types of birds suspected to be present in the Kasegaluk Lagoon area and their habitat affinities in and near the lagoon, a sampling design based on surveys of the various habitats along lagoonal gradients was most appropriate to define habitat associations. This procedure has been used to survey other arctic lagoons in Alaska and Canada (Johnson and Richardson 1981; Johnson 1984) and would enable comparisons of the Kasegaluk Lagoon system with other lagoon systems in Arctic Alaska.

Based on the above information, we established and surveyed four separate strips of habitat in the Kasegaluk Lagoon study area (Figure 2). One strip was along the mainland shoreline and sampled most shoreline, coastal marsh and river delta habitats used by geese and some ducks, and tundra habitats used by a variety of terrestrial birds and mammals. A second strip was through mid-lagoon habitats and sampled areas used by feeding seaducks and seabirds. A third strip was along the lagoonside shoreline of the barrier islands and sampled (1) all of the major passes from the marine system into the lagoon and (2) barrier island shoreline habitats used by resting and feeding waterfowl (geese and ducks), shorebirds, gulls and terns. The fourth strip was located in the nearshore Chukchi Sea about 0.5 km seaward and adjacent to the barrier island, and sampled marine habitats used by seabirds and marine waterfowl (phalaropes, gulls, terns, guillemots, brant, eiders, oldsquaws, etc.). Each of these survey strips was approximately 200 km (110 nmi) in length, and was subdivided into six shorter transects that partitioned the area into smaller sections (Fig. 2). At a survey speed of approximately 175-200 km / hr, each complete survey of the study area lasted approximately 4 to 5 hours, including the time needed to fly between transects.

Survey Techniques

Complete aerial surveys of the study area were conducted on each of two consecutive days, weather permitting. Pairs of surveys were flown two times in 1989 and four times in 1990 (Append. A-1). An additional single-day survey was flown on 11 September 1989. Aerial surveys for this study were conducted from a float-equipped Cessna 206 with an ARNAV-50 long range navigation (LORAN) system for determination of transect start and end points and locations of important features in the study area. In general, however, since the survey path was along or adjacent to a shoreline, geographic features were used to determine the start and end points of transects and locations of important features in the study area. Surveys were conducted with observers seated on both sides of the aircraft, one in the front right seat and one in the rear left of the aircraft. In 1989, sets of surveys took place at approximately 1 week intervals between 24 August and 11 September. In 1990 sets of surveys took place at about two week intervals between 27 July and 10 September (Append. A-l).

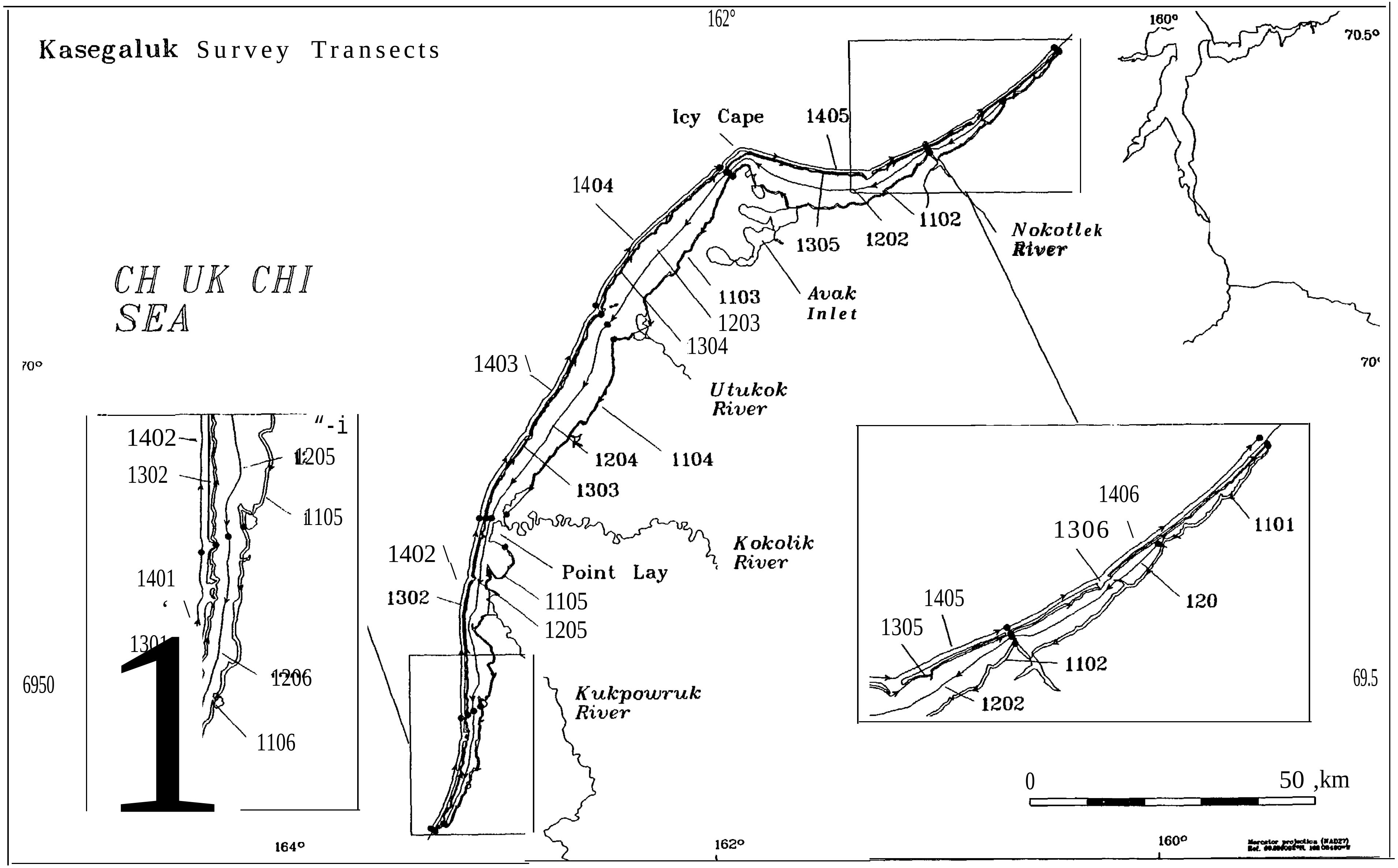


Figure 2. Locations and numbers of aerial survey transect lines in the Kasegaluk Lagoon study area.

All surveys were conducted at an altitude of approximately 45 m ASL and at a ground speed of approximately 175 km/h, which is standard procedure for accurately surveying marine birds from the air (Bradstreet 1979; McLaren 1982). Observers dictated into portable tape recorders all sightings made both on-transect (within 200 m strip of each side of the aircraft) and off-transect (beyond the transect strip). Information recorded included systematic details about the transect and each sighting. The floats on the aircraft obstructed downward visibility and precluded observation directly under the aircraft, so the inner edge of the transect strips were about 50 m away from the midline of the flight track. An audio-intervalometer was used to divide all transects into l-minute time-periods that corresponded to transect segments of approximately equal length (assuming constant ground speed). For each time-period (transect segment) the general and specific habitat type was recorded. This procedure fixed the position of each sighting within approximately 2 km. Such a procedure also enabled the calculation of animal densities on a per-time-period basis as well as on a per-transect or per-habitat type basis. On-transect observations were used to calculate the numbers of birds seen per sq km and on- plus off-transect observations were used to calculate the numbers of birds seen per linear km.

Survey Conditions

Information about the survey conditions was recorded by the left and right prime observers at the start and end of each transect. Conditions were also recorded at other times if changes were noted. Data recorded into portable tape recorders included information about general habitat type, sea state, cloud cover, visibility, precipitation, wind, sun glare, and the time at which a change in conditions was noted.

Sightings

For each sighting, we recorded into portable tape recorders information about the identification of the animal, the number of animals sighted, whether on- or off-transect, direction of travel, association with other individuals (groups, adult /young, pairs), association with other species, age and sex, behavior (feeding, swimming, flying, sexual behavior, etc.), and specific habitat type.

Other Phenomena

During the course of the aerial surveys, several other important kinds of information were collected. Sightings of industrial activities, vessels, boats and hunting parties were recorded and coded on the data sheets. If possible, the types of activities being engaged in at the time of the sighting was also coded.

It has been shown in several studies that marine birds and mammals are not distributed randomly, but are often concentrated at fronts associated with upwellings, eddies, meanders, estuarine plumes, river deltas, salt marshes, islands, spits, and other phenomena associated with barrier island-lagoon systems. The locations of these oceanographic and physiographic features are highly relevant to MMS, especially if they are recurring and represent "hot spots" where marine mammals and birds concentrate seasonally or annually. Water mass discontinuities are often visible during aerial surveys. When possible we recorded the locations and extent of all such discontinuities (convergent fronts, water color changes, drift lines, exposed shoals, spits, etc.) during aerial surveys.

Data Management

Data Entry and Verification

As mentioned above, during the aerial surveys, observations made by each observer were recorded onto audio tape-cassettes. These tapes were reviewed by the observer and transcribed onto special data coding forms as soon as practical after each survey. These forms have been designed for computer data entry and produce automatic carbon copies. Procedures for coding of the aerial survey data were reviewed in advance of the surveys and clearly documented.

After the coding forms have been completed, they were checked by another observer. The duplicate coding forms were then separated and the duplicate copies checked for legibility. The principal investigator retained the original form and the duplicate copy was the responsibility of the data manager. The data forms are also backed-up by the tape recordings made during the surveys. These tapes are retained for several years after the completion of a study.

In the office, the original data forms were entered by keypunch personnel using double-entry verification. Each line on the data entry form was entered as a fixed length, text record. The data entry procedures used custom data entry screens that ensured that records were of uniform length and that data fields were the correct data type. Following data entry, the data records were loaded into a normalized, relational data structure in dBase III format. This loading procedure provided controls for the number of records (lines of data) processed and the number of survey transects. The data were then validated using a custom verification program. The verification program checked the validity of species, behavior, habitat and other codes against standardized code lists; checked for missing data for all observers, time-periods and survey transects; checked the chronological sequence of time-period observations; checked that totals of males and females, etc. were less than or equal to total number of animals observed; and produced control statistics such as the maximum and minimum numbers and frequency of sighting for each species, date, and transect surveyed.

The results of the verification program were reviewed by the data management staff. All problems were documented, brought to the attention of the principal investigator and resolved either through discussion with the observer who completed the form or by reviewing the tape recordings for that transect. Instructions regarding adjustments to aerial survey data coding and corrections to the database were the responsibility of the principal investigator. Adjustments and corrections were made by the data management staff and a new verification file was produced. The file review process was iterative and was repeated until the quality of the data were acceptable to the principal investigator. During this process the data management staff kept detailed records that allowed any changes to be reversed (in a step-wise manner) if required.

Gee-Referenced Data

A digital map of the study area was obtained and the survey transects were digitized for computation of the lengths of transects and to allow computer-mapping of the survey results. The digital study area map was a 1:250,000 scale OCS Official Protraction Diagram dated 12 December 1990, obtained from Minerals Management Service in Anchorage, Alaska, in AutoCAD version 10 format. This map was based on NOAA National Ocean Survey bathymetric data referenced to North American Datum 1927. Map projection data were determined through an iteration process by estimation of projection parameters, transformation of the AutoCAD data, and examination of the root mean square error of control point coordinates after transformation. It was estimated (RMS error = 0.54 mm) that projection parameters for this digital map are the following: 1:250,000 scale Lambert Conformal projection (NAD27), central meridian 162*W, and reference latitudes 68° 40'N and 71° 20'N.

The coast of the Kasegaluk Lagoon study area is dynamic and has altered substantially over time. On inspection it was apparent that the coast of the study area had changed significantly since the map had been produced — the positions of spits, shoals, and passes in the barrier islands had changed in several instances. Corrections were made to the digital map to reflect the configuration of the coast during the study period (summer 1989 and 1990). (These corrections were not based on rigorous survey procedures, but from notations made on NOAA hyrographic charts by the principal investigator during the aerial surveys.) The aerial survey transect lines were then digitized relative to this corrected coastline. The digitizing process produced gee-referenced data and automatically calculated the lengths of the aerial survey transects.

Data Analysis

Custom analysis software was used to calculate linear and areal densities of animals by transect and by l-minute time-period, and to produce tabular summaries of frequencies of animal sightings and group sizes by transect and by habitat type. These programs differentiated between on-transect (within 200 m on each side of the aircraft) and off-transect (beyond

200 m) observations and corrected for situations such as repeat sightings of animals seen by both observers and missing time-period observations for one, or both, observers (for example due to tape recorder malfunctions or periods of poor visibility). Because the data were stored in a dBase data structure we were able to use common database management, statistical and spreadsheet software to also perform ad hoc analyses of the data.

The analysis programs were integrated with the computer mapping software to allow results of standard and ad hoc analyses to be displayed or output as maps. This involved plotting of symbols at the mid-point of each time-period for each transect. The symbol type and size indicated the density of animals for that time-period. Computation of the mid-points of time-periods was based on average air speed, length, time-period interval and start and stop time for each transect. Routine processing involved the production of several hundred maps — maps for each date and year, and for each species or species group of interest.

RESULTS

The following results are presented in a standardized format among taxonomic categories for both years of study. For each major taxomonic group (e.g., loons, seabirds, waterfowl, raptors, terrestrial mammals, marine mammals, etc.) we provide a general overview of results, followed by more detailed treatments of species or species groups (e.g., black brant, oldsquaw, eiders, diving ducks, small shorebirds, etc.). We rely heavily on tables and histograms to show the relative abundances, distributions, and habitat associations of taxa recorded during the aerial surveys. We caution the reader when comparing data from the two years of aerial surveys. Survey periods were very different in 1989 (24 August to 11 September) and 1990 (27 July to 10 September), and consequently the abundance of some species was sometimes very different in the two years.

We make extensive use of maps to show detailed temporal and spatial distributions and abundances of major taxa recorded in relation to major habitat types in the study area, e.g., mainland shoreline, mid-lagoon, barrier islands, and nearshore marine habitats. In most cases we have mapped the areal densities (number per sq km) of on-transect individuals for each 1-minute time-period surveyed in each transect. In some cases, however, such as for brant where most individuals were observed off-transect, we mapped linear densities (number per km) of on- plus off-transect individuals for each l-minute time-period. Summary maps are included in the text, but the large number of daily maps are in Appendix B.

Habitat analyses are based on the numbers of sightings of species in different specific habitats recorded during aerial surveys. The distinction between the numbers of sightings and the numbers of individuals recorded is significant. ***Individuals*** within a flock were considered to be part of a single unit and therefore not independent of each other. ***Sightings,*** on the other hand, were considered to be independent from each other, and therefore comparable.

Loons

Loons were the least abundant of the waterbirds recorded in the study area. Four species or species groups were recorded during the five surveys in 1989 and five were recorded during the eight surveys in 1990 (Tables 2 and 3). There were 236 sightings (7.3% of all sighting) of 404 individual loons (0.2% of all birds) in 1989, and 371 sightings (5.1% of all sightings) of 513 loons (0,2% of all birds) recorded in 1990.

The temporal patterns of loon abundance were somewhat different during in the two years of surveys, primarily because of the different survey schedules in the two years. In 1989 most loons were seen during the surveys in the first week of September, whereas in 1990 peak numbers were recorded during the complete surveys on 27 July and 12 August (Fig. 3). Mid-lagoon and nearshore marine transects could not be surveyed on 28 July and 11 August 1990 because of poor weather, consequently the number of loons recorded on these dates was probably lower than would have been the case if these habitats were surveyed.

Pacific and red-throated loons were the most abundant loons recorded in the study area in 1989 and 1990 — they made up 80.5% of all sightings and 79.3% of all individuals in 1989, and 91.9% of all sightings and 93.0% of all individuals in 1990 (Tables 2 and 3). These two species, along with the group classified as unidentified loons, represented all but five sightings of seven individuals recorded during the 1989 surveys, and all but 14 sightings of 18 individuals recorded in 1990.

Pacific Loon (*Gavia pacifica*)

The overall mean density of Pacific loons seen on-transect in 1989 and 1990 was similar — 0.06/sq km vs. 0.05/sq km, respectively (Table 4). The highest densities were recorded in the Kokolik River delta, in the Icy Cape area, and in the northeastern part of the study area (Figs. 4 and 5). Peak densities of Pacific loons on l-minute transect segments in these areas were 5 to 6 loons/sq km on 11 September 1989 (Append. B-1). High densities were also recorded on transect segments along the mainland shoreline — 7.83 Pacific loons per sq km were recorded on a transect segment in the Kokolik River delta (transect 1104) on 8 September 1990 (Append. B-l).

Table 2. Total number of bird sightings and individuals seen both on- and off-transect during 5 aerial surveys in Kasegaluk Lagoon, Chukchi Sea, Alaska, 24 August toll September 1989.

species	No. Sightings	% of All Bird Sightings	No. Indiv.	% of All Indiv. Birds	Species	No. Sightings	% of All Bird Sightings	No. Indiv.	% of Au Indiv. Birds
Yellow-billed Loon	4	0.1	5	0.0	Greater White-fronted Goose	49	1.5	1,329	0.6
Pacific Loon	114	3.5	2(KI	0.1	Canada Goose	4	0.1	55	0.0
Arctic Loon	1	0.0	2	0.0	Black Brant	543	16.7	143,918	70.2
Red-throated Loon	76	2.3	122	0.1	Tundra Swan	28	0.9	71	0.0
Unid. Loon	41	1.3	77	0.0	All Waterfowl	1,873	57.7	195,015	95.1
All Loons	236	7.3	406	0.2	Unid. Phalarope	7	0.2	39	0.0
Black Guillemot	8	0.2	10	0.0	Dunlin	1	0.0	5	0.0
Parasitic Jaeger	6	0.2	6	0.0	Whimbrel	1	0.0	1	0.0
Long-tailed Jaeger	3	0.1	7	0.0	Black-bellied Plover	10	0.3	28	0.0
Glaucous Gull	910	28.0	2,687	1.3	Lesser Golden Plover	3	0.1	9	0.0
Herring Gull	1	0.0	1	0.0	Unid. Plover	2	0.1	12	0.0
Arctic Tern	12	0.4	20	0.0	Small Shorebird	94	2.9	6,595	3.2
All Seabirds	940	28.9	2,731	1.3	Large Shorebird	3	0.1	6	0.0
Red-breasted Merganser	44	1.4	2,239	1.1	All Shorebirds	121	3.7	6,695	3 3
Northern Pintail	55	1.7	%7	0.5	Northern Harrier	2	0.1	2	0.0
Greater Scaup	2	0.1	76	0.0	Golden Eagle	1	0.0	1	0.0
Unid. Scaup	17	0.5	421	0.2	Bald Eagle	1	0.0	1	0.0
OldSquaw	478	14.7	24,679	12.0	Gyrfalcon	2	0.1	2	0.0
Common Eider	437	13.5	7,046	3.4	Snowy Owl	62	1.9	64	0.0
Unid. Eider	3	0.1	54	0.0	All Raptors	68	2.1	70	0.0
Black Scoter	3	0.1	18	0.0	Common Raven	3	0.1	3	0.0
White-winged Scoter	9	0.3	200	0.1	Snow Bunting	2	0.1	31	0.0
surf Scoter	80	2.5	1,155	0.6	Lapland Longspur	1	0.0	5	0.0
Unid. Scoter	4	0.1	69	0.0	Northern Wheatear	3	0.1	4	0.0
Unid. Diving Duck	109	3.4	12,552	6.1	Unid. Passerine	1	0.0	5	0.0
Lesser Snow Goose	8	0.2	166	0.1	All Passerine	10	0.3	48	0.0

Table 3. Total number of bird sightings and individuals seen troth on- and off-transect during 8 aerial surveys in Kasegaluk Lagoon, Chukchi Sea, Alaska, 27 July to 10 September 1990.

species	No. Sightings	% of All Bird Sightings	No. Indiv.	% of All Indiv. Birds
Yellow-billed Loon	14	0.2	18	0.0
Pacific Loon	126	1.7	166	0.1
Red-throated Loon	215	3.0	311	0.1
Unid. bon	16	0.2	18	0.0
All Loons	3n	5.1	513	0.2
Black Guillemot	1	0.0	1	0.0
Thick-billed Murre	2	0.0	2	0.0
Small Alcid	1	0.0	1	0.0
Pomarine Jaeger	1	0.0	1	0.0
Parasitic Jaeger	34	0.5	S4	0.0
Long-tailed Jaeger	5	0.1	6	0.0
Unid. Jaeger	5	0.1	5	0.0
Black-legged Kittiwake	38	0.5	733	0.3
Glaucous Gull	2,282	31.5	15,490	7.1
Herring Gull	3	0.0	3	0.0
Sabine's Gull	17	0.2	58	0.0
Arctic Tern	718	9.9	11,294	5.2
Aleutian Tern	2	0.0	5	0.0
Unid. Tern	1	0.0	6	0.0
Northern Fulmar	2	0.0	2	0.0
All Seabirds	3,112	43.0	27,661	12.7
Red-breasted Merganser	65	0.9	4,555	2.1
Green-winged Teal	11	0.2	53	0.0
Northern Pintail	301	4.2	6,989	3.2
Greater Scaup	1	0.0	60	0.0
OldSquaw	796	11.0	33,084	15.2
Common Eider	609	8.4	6,540	3.0
King Eider	1	0.0	4	0.0
Unid. Eider	1	0.0	2	0.0
White-winged Scoter	1	0.0	4	0.0
Surf Scoter	56	0.8	348	0.2
Unid. Scoter	2	0.0	5	0.0
Unid. Diving Duck	50	0.7	4,534	2.1

species	No. Sightings	% of Au Bird Sightings	No. Indiv.	% of All Indiv. Birds
Unid. Duck	4	0.1	33	0.0
Lesser Snow Goose	23	0.3	1,033	0.5
Greater White-fronted Goose	187	2.6	10,C98	4.6
Canada Goose	7	0.1	106	0.0
Black Brant	858	11.8	82,906	38.1
Tundra Swan	46	0.6	138	0.1
All Waterfowl	3,019	41.7	150,492	69.1
Lesser Sandhill Crane	7	0.1	25	0.0
Red Phalarope	8	0.1	59	0.0
Northern Phalarope	1	0.0	1	0.0
Unid. Phalarope	81	1.1	3,101	1.4
Long-billed Dowitcher	3	0.0	83	0.0
Dunlin	8	0.1	279	0.1
Bar-tailed Godwit	1	0.0	3	0.0
Black-bellied Plover	16	0.2	71	0.0
Lesser Golden Plover	13	0.2	209	0.1
Unid. Plover	1	0.0	4	0.0
Small Shorebird	387	5.3	30,441	14.0
Large Shorebird	89	1.2	4,395	2.0
All Shorebirds	608	8.4	38,646	17.8
Northern Harrier	3	0.0	3	0.0
Rough-legged Hawk	1	0.0	1	0.0
Golden Eagle	5	0.1	5	0.0
Gyrfalcon	4	0.1	4	0.0
Peregrine Falcon	3	0.0	3	0.0
Short-eared Owl	2	0.0	2	0.0
Snowy Owl	78	1.1	79	0.0
All Raptors	96	1.3	97	0.0
Common Raven	5	0.1	9	0.0
Snow Bunting	9	0.1	120	0.1
Lapland LongSpur	3	0.0	5	0.0
Unid. Passerine	12	0.2	81	0.0
All Passerine	29	0.4	215	0.1

Table 4. Mean densities (no/sq km) of birds recorded during aerial surveys Of the Kasegaluk Lagoon study area in 1989 and 1990. For those species marked with an asterisk (*), linear densities (birds/km) are presented (see text).

species	Density (birds/sq km)			
	19s9		1990	
	Mean	s.d.	Mean	s.d.
Yellow-billed Loon	0.01	0.04	0.01	0.04
Pacific Loon	0.06	0.12	0.05	0.08
Arctic Loon	0.00	0.03		
Red-throated Loon	0.06	0.14	0.11	0.20
Urdd. Loon	0.01	0.05	0.01	0.02
Black Guillemot	0.01	0.04	0.00	0.01
Thick-billed Murre			0.00	0.01
Small Alcid			0.00	0.01
Pomarine Jaeger			0.00	0.00
Parasitic Jaeger	0.00	0.01	0.02	0.08
Long-tailed Jaeger	0.00	0.04	0.00	0.00
Unid. Jaeger			0.00	0.00
Black-legged Kittiwake			0.10	052
Glaucous Gull	0.67	0.97	2.89	754
Herring Gull	0.00	0.01	0.00	0.01
Saline's Gull			0.02	0.13
ArcticTern	0.01	0.04	3.29	9.06
Aleutian Tem			0.00	0.02
Unid. Tern			0.00	0.03
Northern Fulmar			0.00	0.01
Red-breasted Merganser	0.66	3.81	134	6.24
Green-winged Teat			0.02	0.12
Northern Pintail	036	1.64	2.34	7.88
Greater Scaup	0.04	0.40	0.02	030
Unid. Scaup	0.29	1.76		
Oldsquaw	5.s2	14.07	11.45	3231
Common Eider	2.45	4.76	2.27	4.98
King Eider			0.00	0.00
Unid. Eider	0.02	0.21	0.00	0.01
Black Scoter	0.01	0.09		
White-winged Scoter	0.04	0.25	0.00	0.03
surf Scoter	1.01	4.09	0.10	037
Unid. Scoter	0.00	0.04	0.00	0.00
Unid. Diving Duck	0.41	281	0.39	2.64

Species	Density (birds/sq km)			
	19S9		1990	
	Mean	s.d.	Mean	s.d.
Unid. Duck			0.01	0.07
Lesser Snow Goose”	0.04	0.20	0.15	0.69
Greater White-fronted Goose”	0.31	1.19	2.07	7.16
Canada Goose*	0.01	0.09	0.02	0.15
Black Brant*	3299	123.71	12.90	36.88
Tundra Swan	0.04	0.18	0.04	0.14
Lesser Sandhill Crane			0.01	0.06
Red Phalarope			0.02	0.23
Northern Phalarope			0.00	0.04
Unid. Phalarope	0.02	0.13	1.42	11.91
Long-breed Dowitcher			0.00	0.04
Dunlin	0.00	0.03	0.14	1.28
Bar-tailed Godwit			0.00	0.01
Whimbrel	Oat	0.00		
Black-bellied Plover	0.02	0.10	0.04	034
Lesser Golden Plover	0.00	0.04	0.10	0.70
Unid. Plover	0.01	0.06	0.00	0.03
Small Shorebird	4.39	21.63	17.10	71.31
Medium Shorebird			236	15.17
Large Shorebird	0.00	0.02		
Northern Harrier	0.00	0.00	0.00	0.00
Rough-legged Hawk			0.00	0.01
Golden Eagle	0.00	0.01	0.00	0.01
Batd Eagle	0.00	0.00		
Gyrfalcon	0.00	0.01	0.00	0.01
Peregrine Falcon			0.00	0.01
Short-em-cd Owl			0.00	0.01
Snowy Owl	0.02	0.07	0.02	0.06
Common Raven	0.00	0.01	0.00	0.03
Snow Bunting	0.02	0.17	0.05	0.38
Lapland Longspur	0.00	0.03	0.00	0.02
Northern Wheatear	0.00	0.02		
Unid. Passerine	0.00	0.03	0.03	0.15

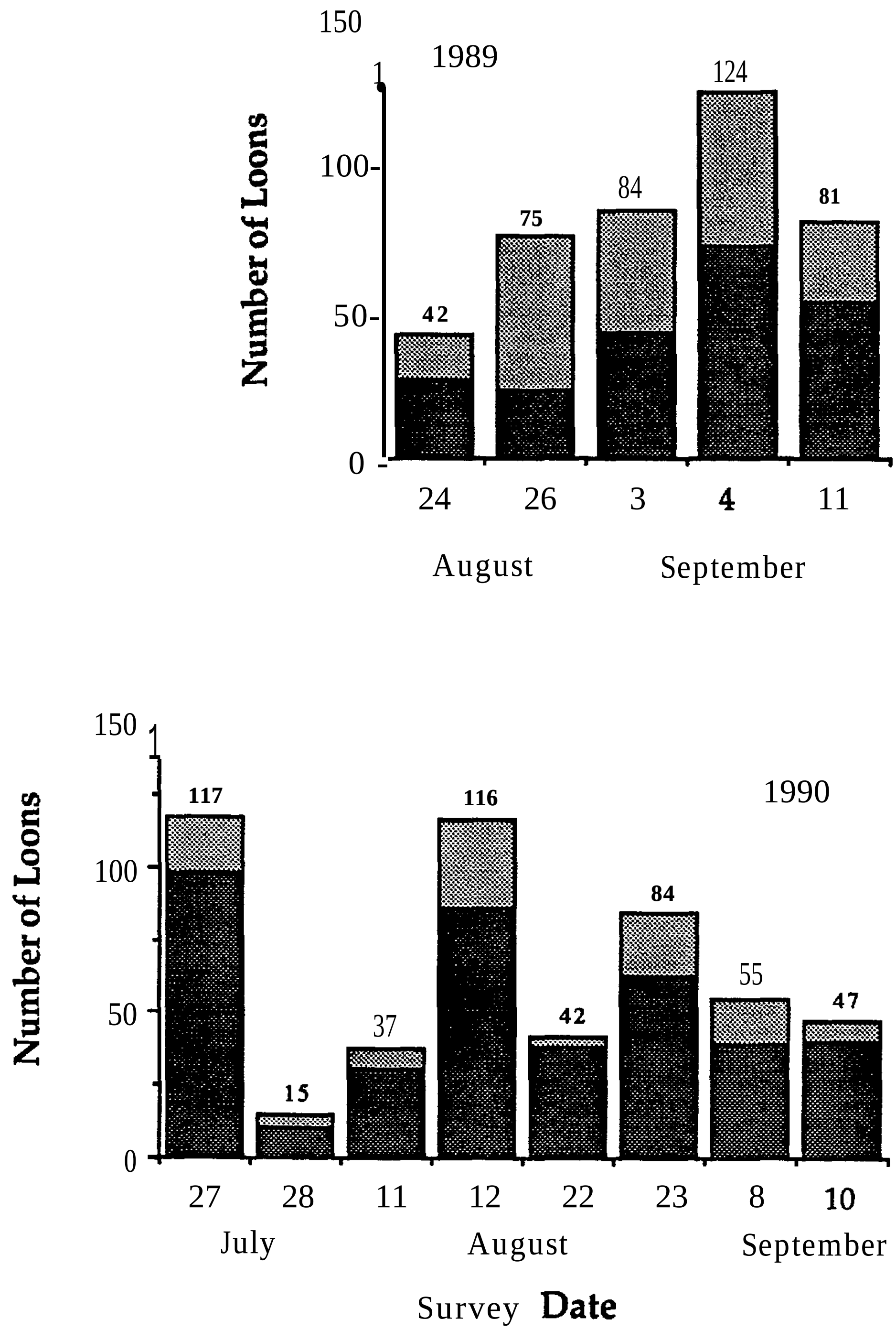


Figure 3. Total number of loons seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

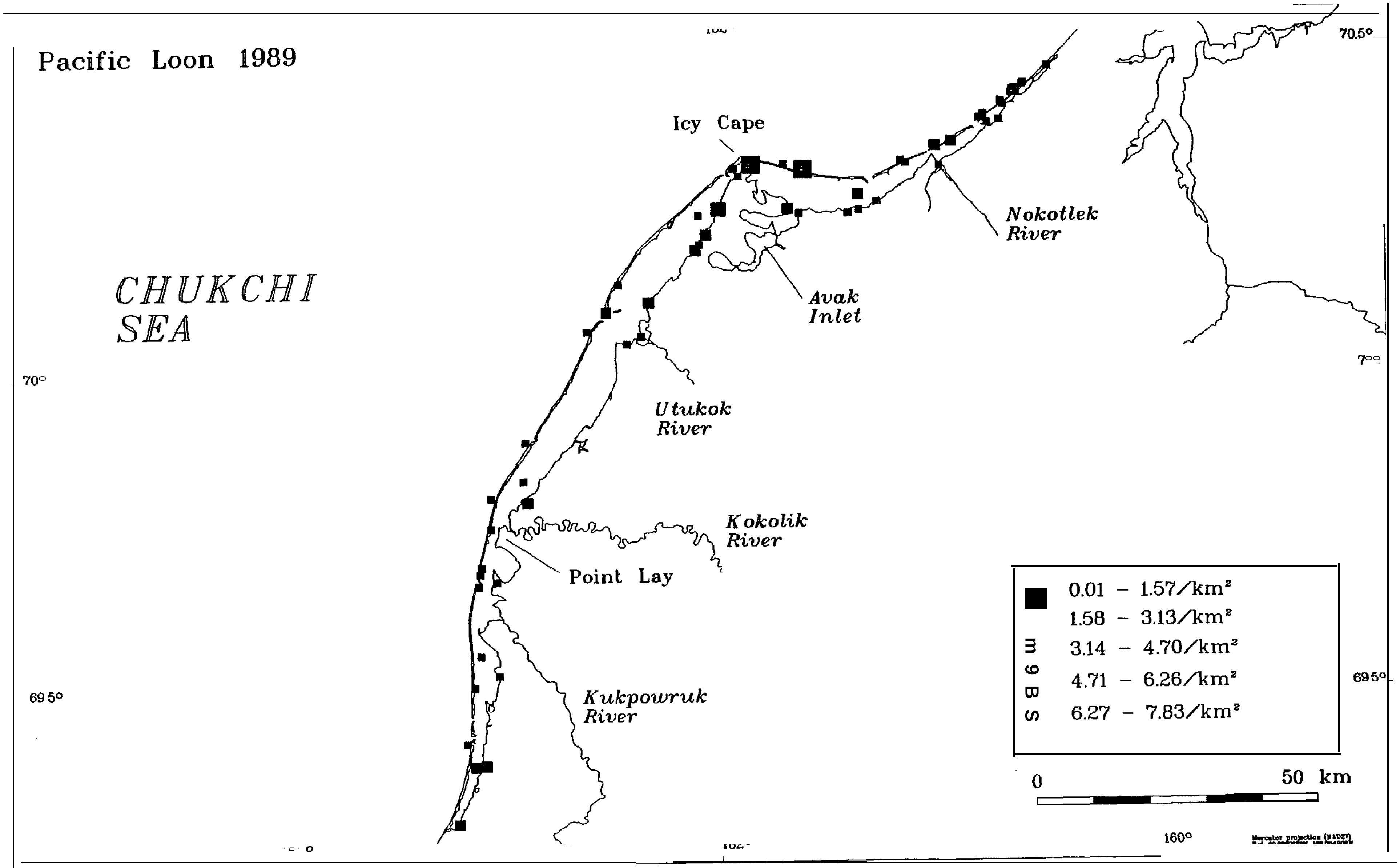


Figure 4. Summary of densities of Pacific loons on 1-minute transect segments in the Kasegaluk Lagoon study area in 1989.

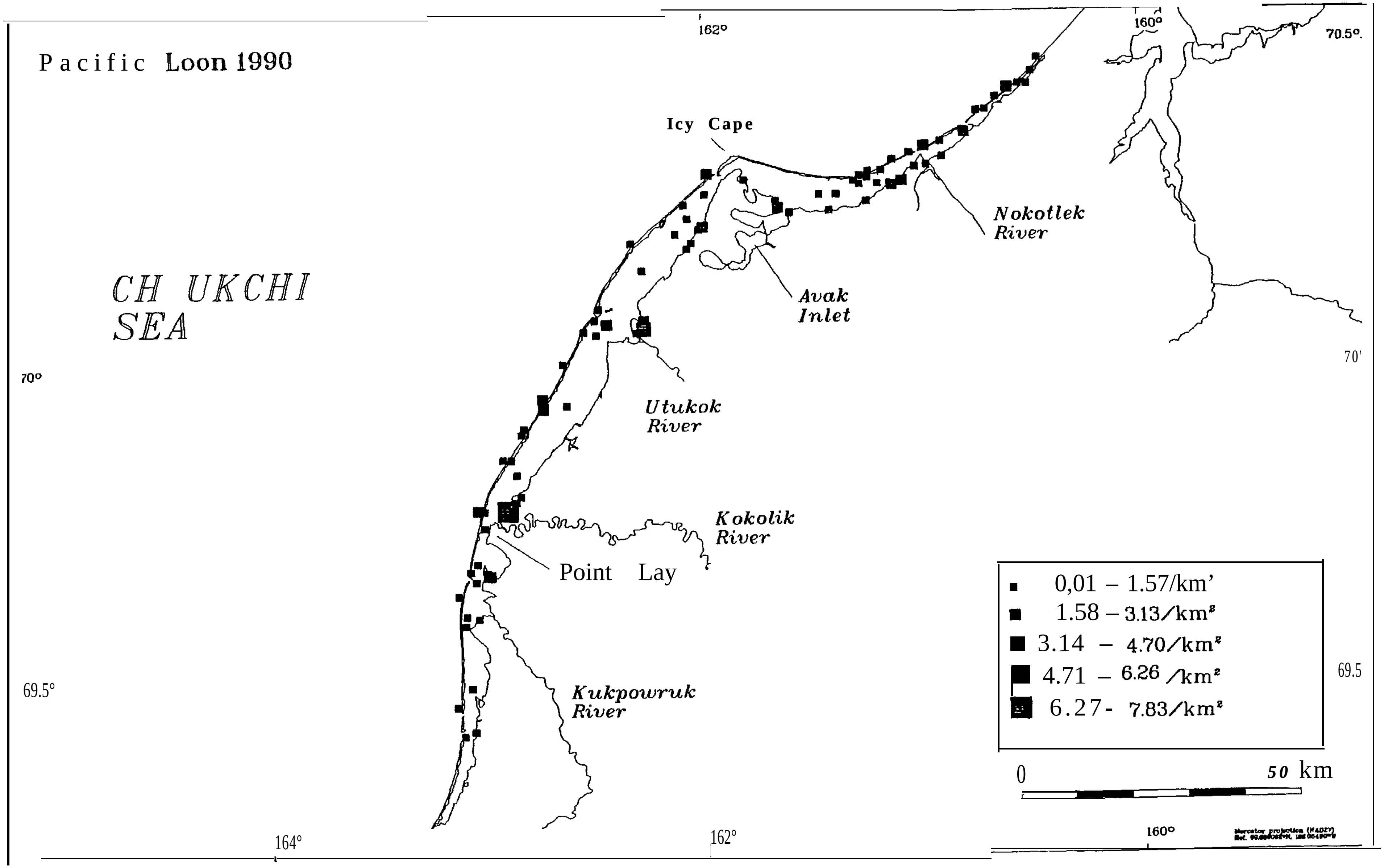


Figure 5. Summary of densities of Pacific loons on l-minute transect segments in the Kasegaluk Lagoon study area in 1990.

Table 5. Habitat associations of pacific loons dining aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine	31	27.2	7	5.6
Ocean Beach			1	0.8
Ocean Surf	2	1.8		
Lagoon	58	50.9	76	60.3
Lagoon-Mainland margin*	20	17.5	4	3.2
Mid-Lagoon*	19	16.7	31	24.6
Lagoon-Island margin'	19	16.7	41	32.5
Shoal/Spit				
River Delta			3	2.4
Pond/Lake on Tundra	21	18.4	34	27.0
Tundra	1	0.9	5	4.0
Coastal Marsh				
Mudflat			-	
River				
Stream	1	0.9		
-All Habitats	114	100.0	126	100.0

An asterisk(*) indicates that this habitat was a subset of the more comprehensive category "Lagoon".

Habitat analyses indicated that about 50% of Pacific loon sightings in 1989 were in lagoon habitats (Table 5). Sightings were about equally distributed among the mid-lagoon, the lagoon-barrier island margin, and the lagoon-mainland margin. A large proportion of sightings in 1989 (27.2%) were also recorded in nearshore marine (ocean) habitats. In 1990, when a full season of aerial surveys were conducted, a much larger proportion of Pacific loon sightings (60%) were in lagoon habitats. In 1990, however, most sightings in lagoon habitats were along the lagoon-barrier island margin and in mid-lagoon habitats (Table 5). There were very few sightings along the lagoon-mainland margin in 1990.

Red-throated Loon (*Gavia stellata*)

The overall mean density of red-throated loons seen on-transect in 1990 was nearly twice the overall mean for 1989 (0.1 1 vs. 0.06/sq km, respectively; Table 4). In 1989 the highest densities of red-throated loons were recorded on nearshore marine and barrier island transects, mainly in the southwestern part of the study area (i.e., SW of Icy Cape; Fig. 6). In 1990 the highest densities were also recorded on nearshore marine transects in the southwestern part of the study area, especially on early surveys (e.g., 27 July) (Fig. 7). Later in the season, high densities of red-throated loons were also recorded on barrier island and mid-lagoon transects (See Append. B-2). The highest density of red-throated loons in the study area during the two years of surveys was 5 loons/ sq km recorded on a l-minute transect segment near the mouth of Avak Inlet on 26 August 1989 (Append. B-2).

Habitat analyses indicated that nearly 60% of red-throated loon sightings in 1989 were in lagoon habitats, mainly (30.3%) in the narrow band of habitat within 400 m of the lagoonsides of the barrier islands (Table 6). In 1989 a large proportion of sightings (31.6%) were also recorded in nearshore marine (ocean) habitats. In 1990, when a full season of aerial surveys were conducted, a much larger proportion of red-throated loon sightings (73%) were in lagoon habitats. As in 1989, most of these sightings in lagoon habitats were along the barrier islands (51 .6% of all 1990 sightings). There were far fewer sightings of red-throated loons innearshore marine habitats in 1990, but there were markedly more sightings on tundra ponds and lakes (Table 6).

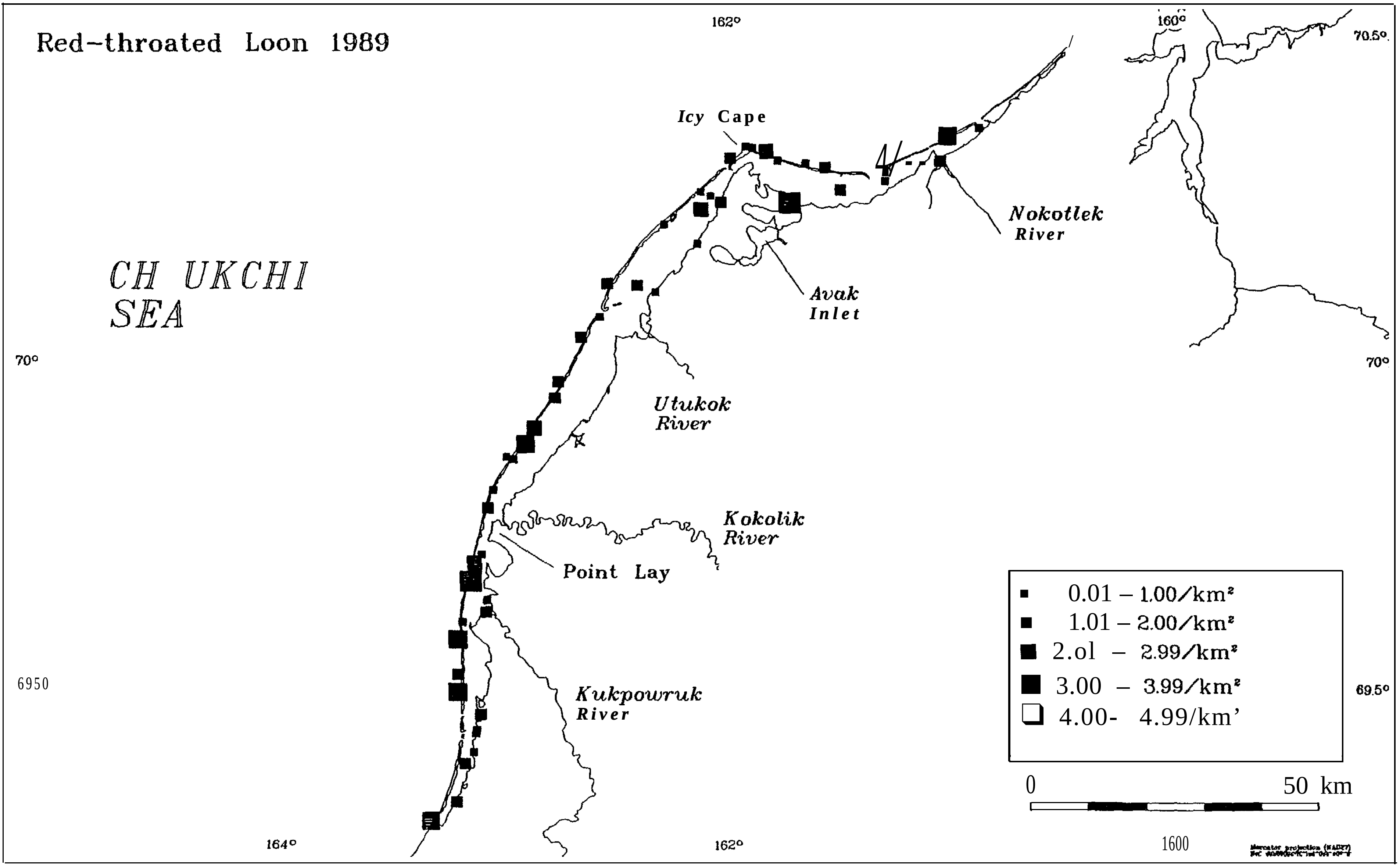


Figure 6. Summary of densities of red-throated loons on l-minute transect segments in the **Kasegaluk** Lagoon study area in 1989.

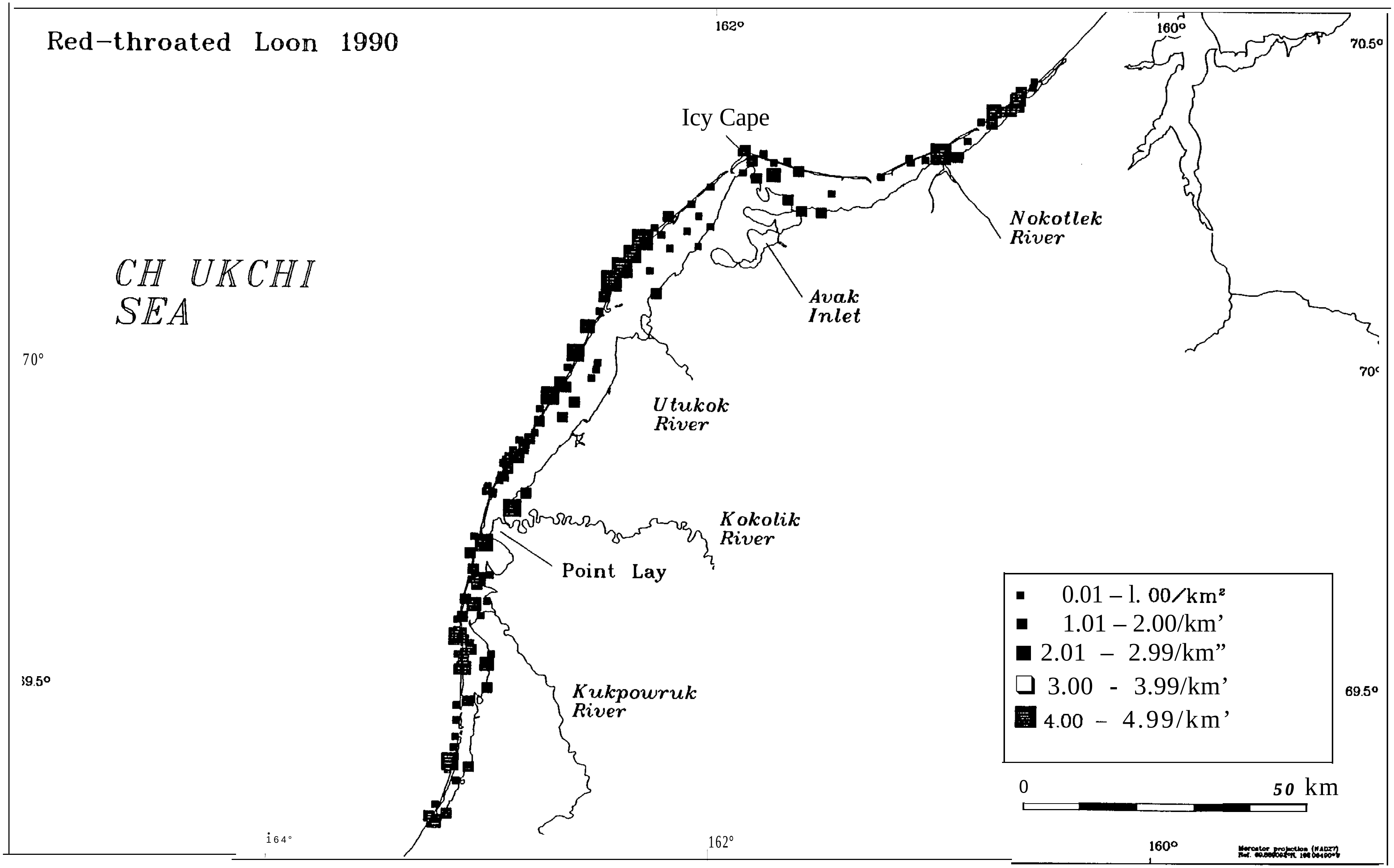


Figure 7. Summary of densities of red-throated loons on l-minute transect segments in the **Kasegaluk** Lagoon study area in 1990.

Table 6. Habitat associations of red-throated loons during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine	24	31.6	17	7.9
Ocean Beach			3	1.4
Ocean Surf	1	1.3	1	0.5
Lagoon	45	59.2	157	73.0
Lagoon-Mainland margin*	10	13.2	6	2.8
Mid-Lagoon*	12	15.8	40	18.6
Lagoon-Island margin”	23	30.3	111	51.6
Shoal/Spit				
River Delta			2	0.9
Pond/Lake on Tundra	3	3.9	28	13.0
Tundra	1	1.3	5	2.3
Coastal Marsh	1	1.3		
Mudflat			1	0.5
River	1	1.3	1	0.5
Stream				
All Habitats	76	100.0	215	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

Seabirds

Seabirds were the third most abundant group of birds recorded during aerial surveys in 1989 and 1990. Six species were recorded during the five surveys in 1989 and 15 species or species groups were recorded during the eight surveys in 1990 (Tables 2 and 3). As a group, seabirds constituted 28.9% (940) of all bird sightings and 1.3% (2731) of all individual birds recorded in 1989. In 1990 they constituted 43.0% (3112) of all sightings and 12.7% (27,661) of all individuals. The glaucous gull and arctic tern were the two most abundant and widespread species of seabirds recorded in the study area in both years. They were especially abundant in 1990 when a full complement of aerial surveys were conducted. The difference in abundance of these two species in the two years of surveys was most marked for arctic terns.

Arctic Tern (*Sterna paradisaea*)

In 1989 the aerial surveys commenced on 24 August and there were only 12 sightings (0.4% of all sightings) of 20 individual arctic terns (cO.170 of all individuals). In 1990 the surveys commenced a month earlier, on 27 July, and there were 718 sightings (9.9%) of 11,294 individual arctic terns (5.2%; Tables 2 and 3). The overall density of arctic terns in 1990 was two orders of magnitude greater than in 1989 (Table 4). Virtually all of the terns recorded in 1990 were during the period 27 July through 23 August, i.e., the period not covered during the 1989 surveys (Fig. 8).

The spatial distribution of arctic terns during the two years of surveys was only marginally comparable because of the drastic difference in the number of birds seen in the two years. In 1989 when few birds were seen, most were along the barrier islands SW of Icy Cape and in the marshes at the far SW end of the study area (Fig. 9). In 1990 most arctic terns were also recorded along the barrier islands, but peak densities were in the area around Icy Cape and Blossom Shoals, and at Akoliakatat Pass, Utukok Pass, Kukpowruk Pass, and in the marshes at the extreme SW end of the study area (Fig. 10). The peak density of arctic terns on a l-minute transect segment was 1638 birds/sq km recorded at Icy Cape on 12 August 1990 (Append. B-3).

Habitat analyses indicated that nearly two-thirds of all arctic tern sightings in both 1989 and 1990 were in lagoon habitats, mainly in the narrow

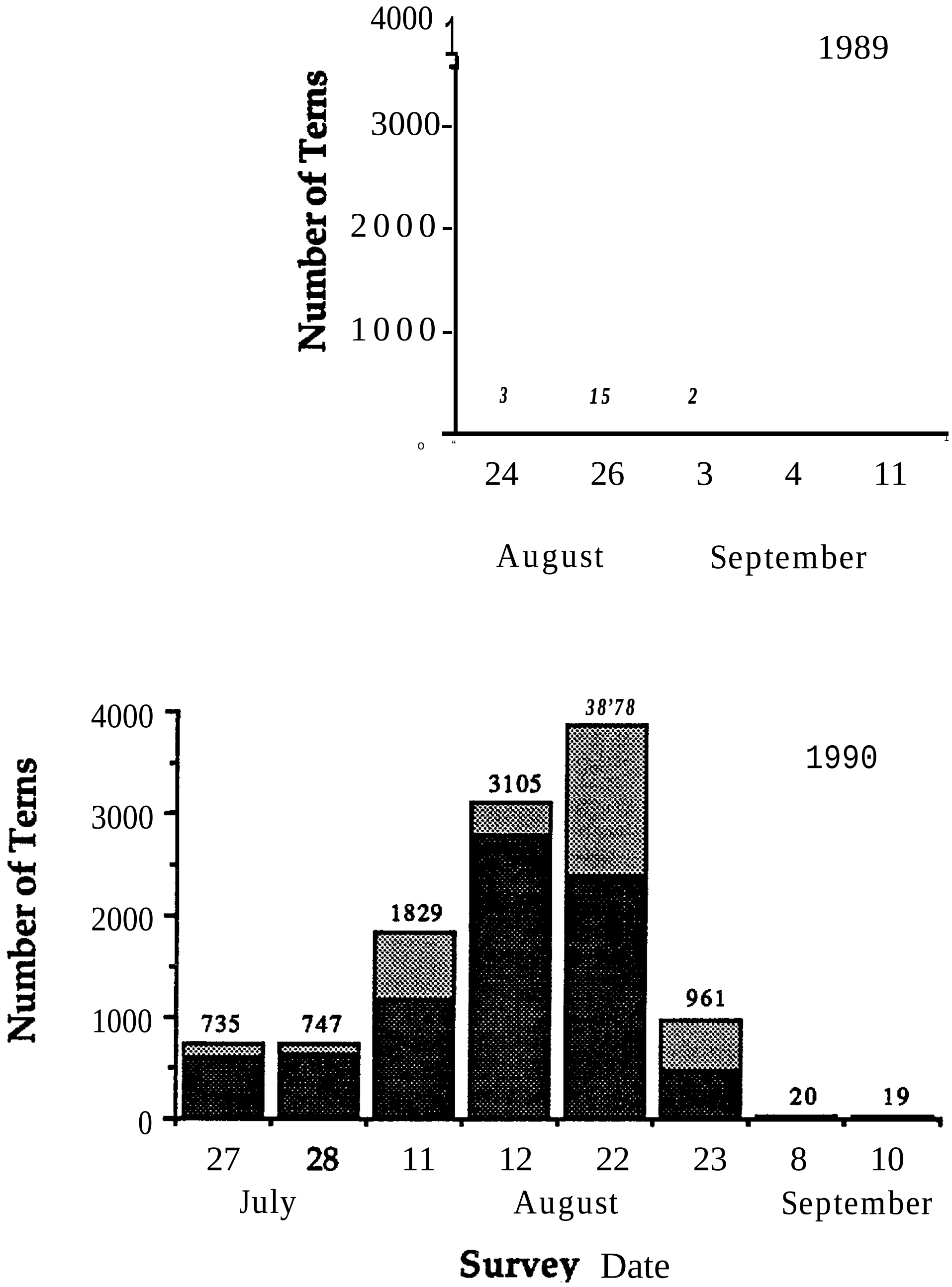


Figure 8. Total number of arctic terns seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

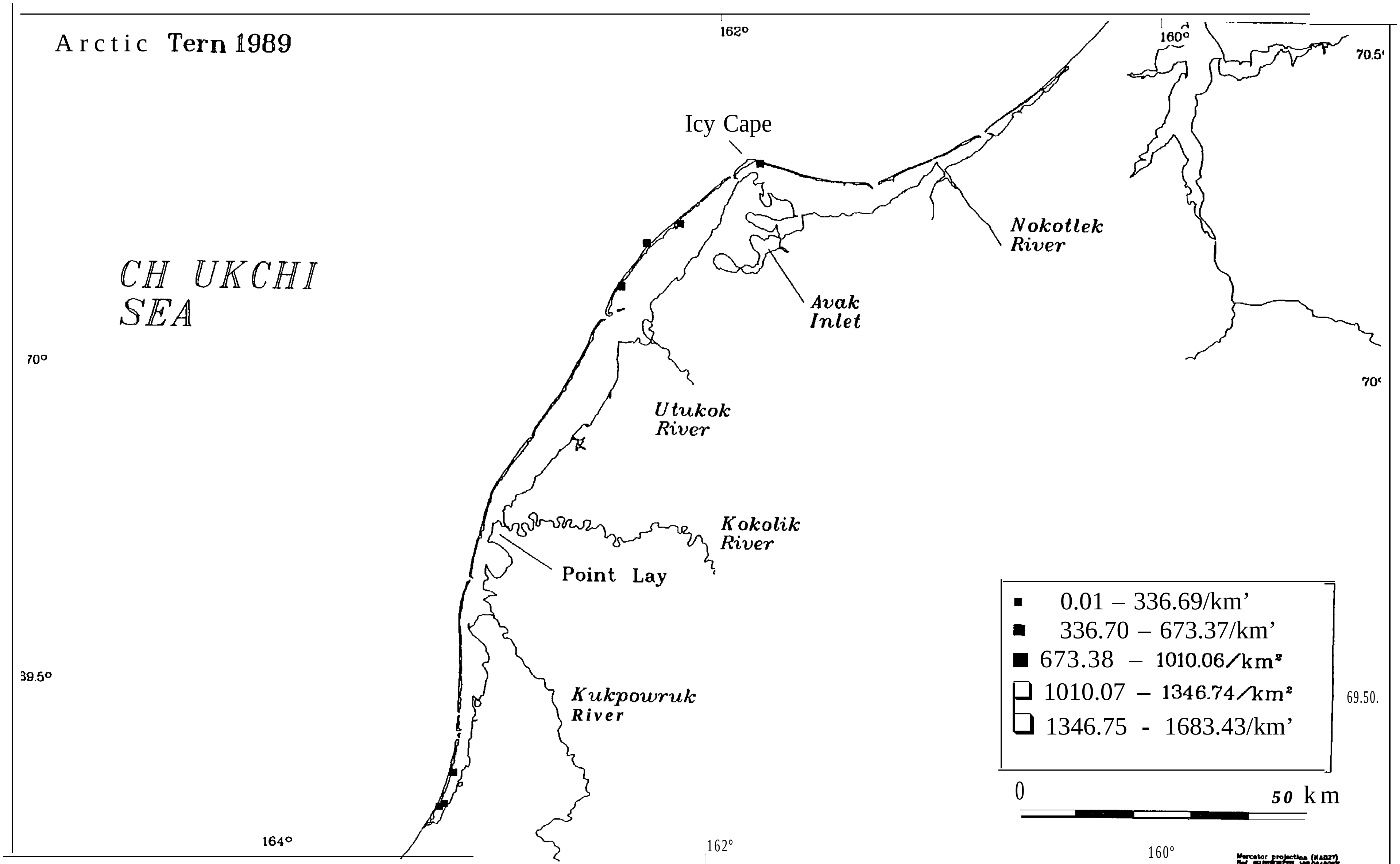


Figure 9. Summary of densities of arctic terns on l-minute transect segments in the Kasegaluk Lagoon study area in 1989.

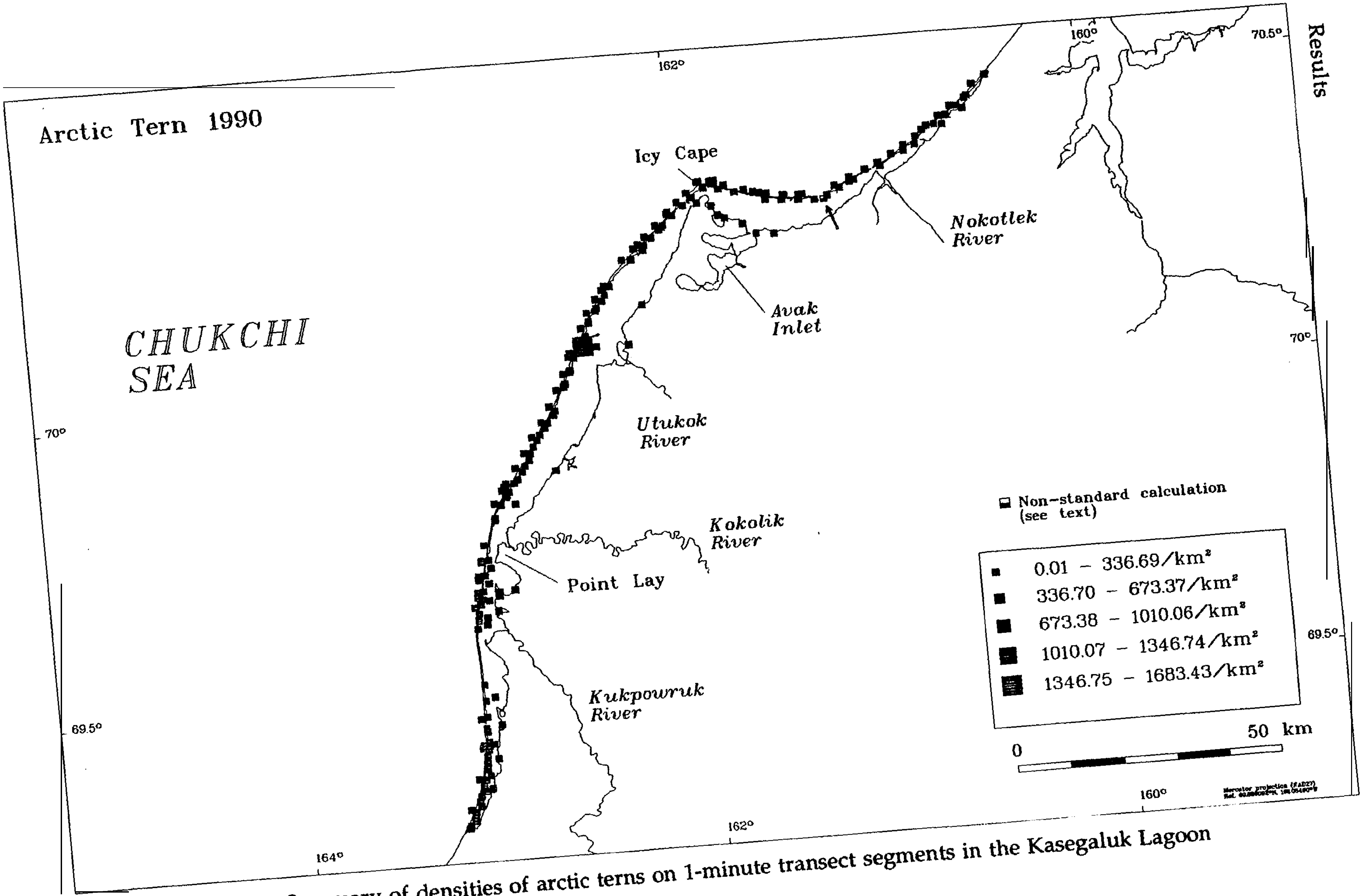


Figure 10. Summary of densities of arctic terns on 1-minute transect segments in the Kasegaluk Lagoon study area in 1990.

Table 7. Habitat associations of arctic terns during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine	3	25.0	25	3.5
Ocean Beach			64	8.9
Ocean Surf			6	0.8
Lagoon	8	66.7	462	64.3
Lagoon-Mainland margin*			1	0.1
Mid-Lagoon*	1	8.3	21	2.9
Lagoon-Island margin*	6	50.0	342	47.6
Lagoon Pass*	1	8,3	98	13.6
Shoal/Spit			9	1.3
River Delta			3	0.4
Pond/Lake on Tundra			4	0.6
Tundra	-		31	4.3
Coastal Marsh	1	8.3	21	2.9
Mudflat	-		93	13.0
River				
Stream				
All Habitats	12	100.0	718	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

band of habitat within 400 m of the lagoonsides of the barrier islands (about 50%; Table 7). There were so few sightings in 1989 that little can be said of habitat associations by arctic terns in that year. In 1990, however, more arctic terns were recorded in mudflat habitats and the passes between the barrier islands connecting Kasegaluk Lagoon with the Chukchi Sea (Table 7).

Glaucous Gull (Larus hyperboreus)

Glaucous gulls were widespread and abundant in the study area in 1989, but far less abundant than recorded in 1990 (Tables 2-4). In fact, the largest number of glaucous gulls reported on a survey in 1989 (838 on 11 September) was only marginally larger than the smallest number recorded on any survey in 1990 (822 on 12 August; Fig. 11). The largest number of glaucous gulls recorded during 1990 was on 27 July, on the first bird survey of the season. In fact, over half (8487 birds; 54.8%) of all glaucous gulls recorded in 1990 were during the first set of surveys on 27 and 28 July, about two weeks after the beluga harvest at Point Lay.

The spatial distribution of glaucous gulls was similar during the two years of surveys. In both years virtually all sightings were recorded in lagoon habitats along barrier island shorelines in the study area (Figs. 12 and 13). An especially high density of glaucous gulls (1478 gulls/sq km) was recorded on a l-minute segment of a barrier island-lagoon shoreline transect (transect 1302 on 27 July 1990) adjacent to Point Lay where several dozen beluga whale carcasses were located in 1990 (Fig. 13; Append. B-4).

Habitat analyses indicated that the largest proportions of glaucous gull sightings in 1989 and 1990 (39.9% and 47.570, respectively) were in lagoon habitats, mainly in the narrow band within 400 m of the barrier island shoreline (Table 8). A large proportion of sightings in 1989 and 1990 (30.3% and 20.1 %, respectively) were also recorded along the oceanside beaches of the barrier islands.

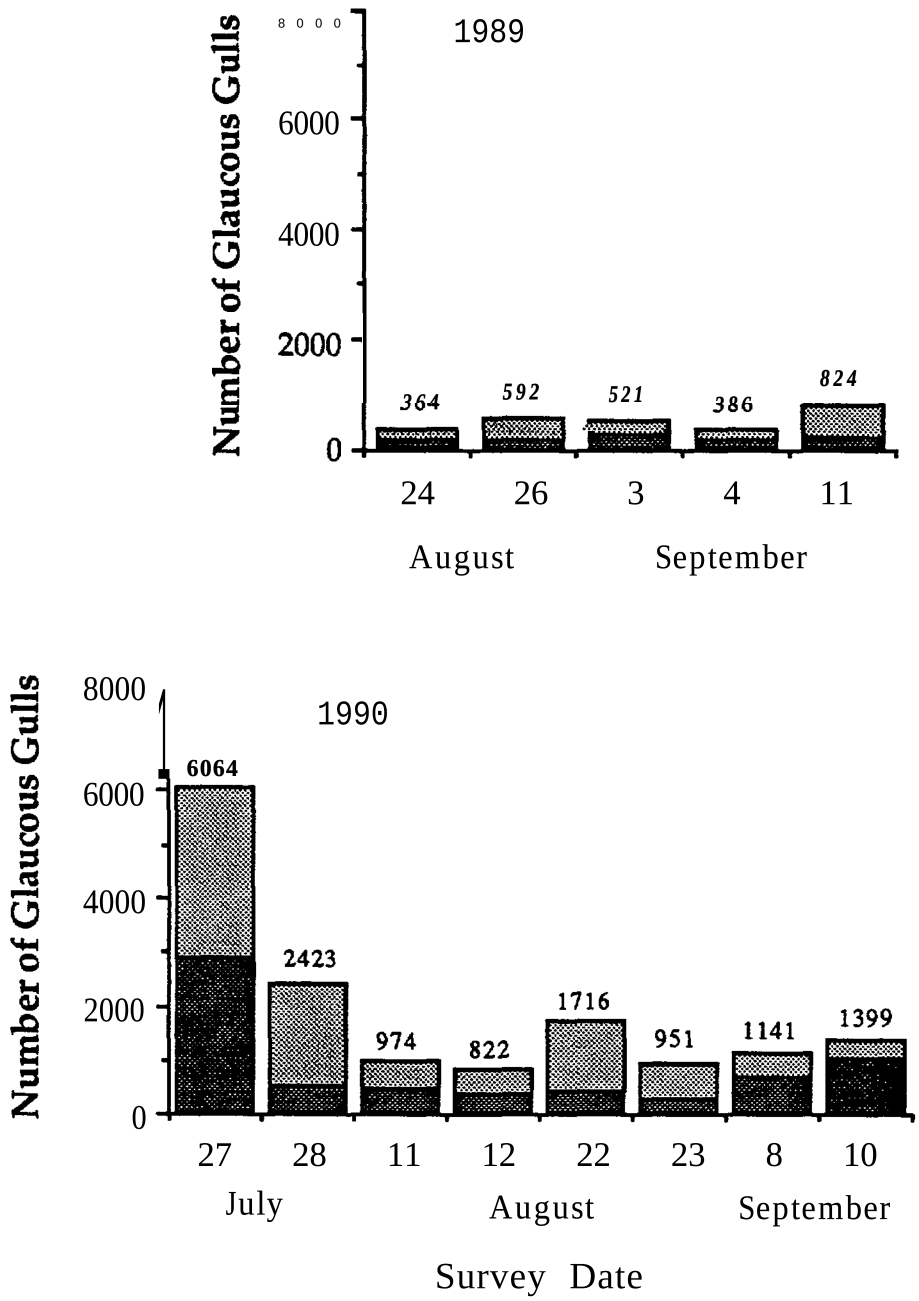


Figure 11. Total number of glaucous gulls seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

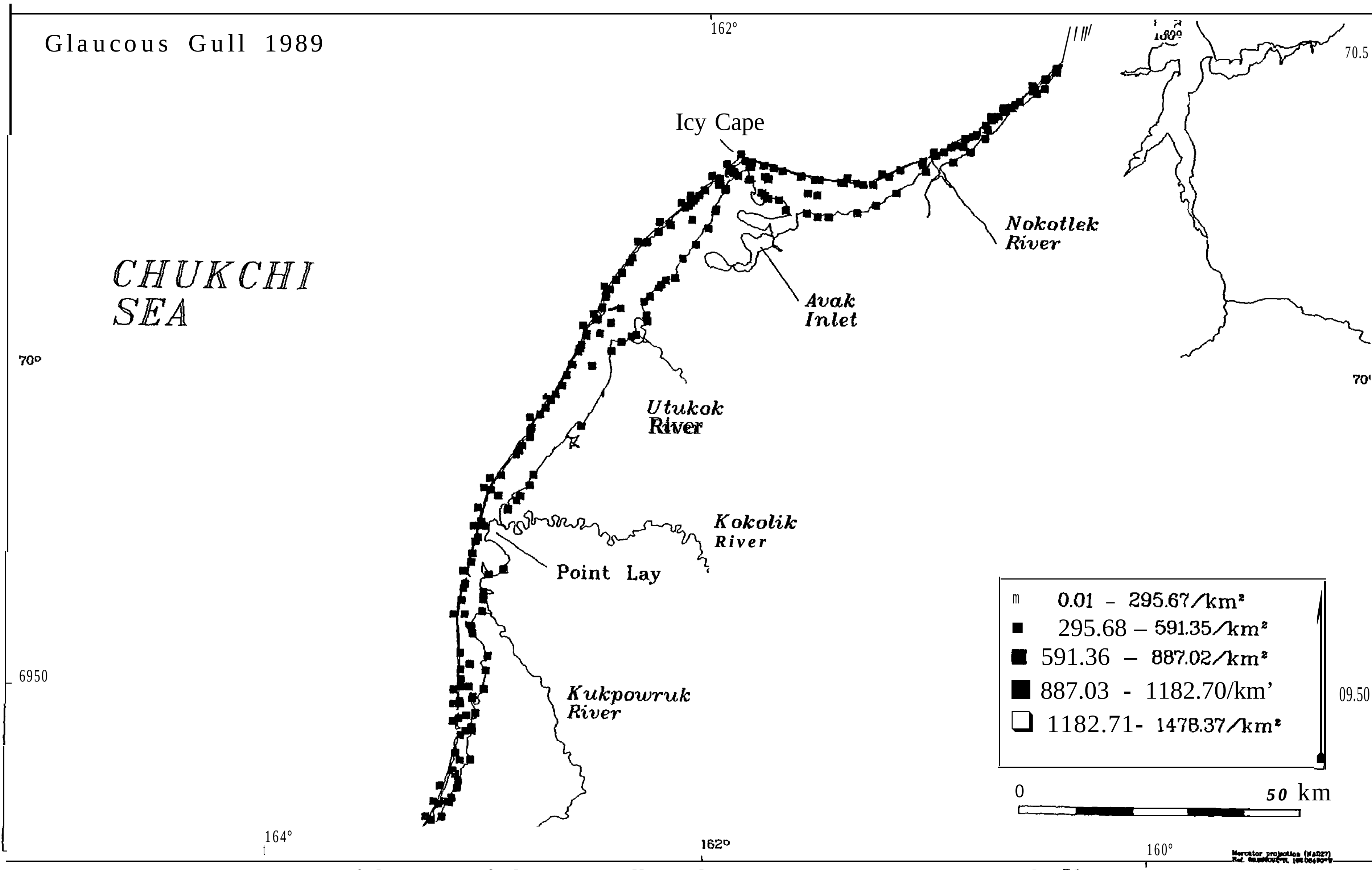


Figure 12. Summary of densities of glaucous gulls on l-minute transect segments in the Kasegaluk Lagoon study area in 1989.

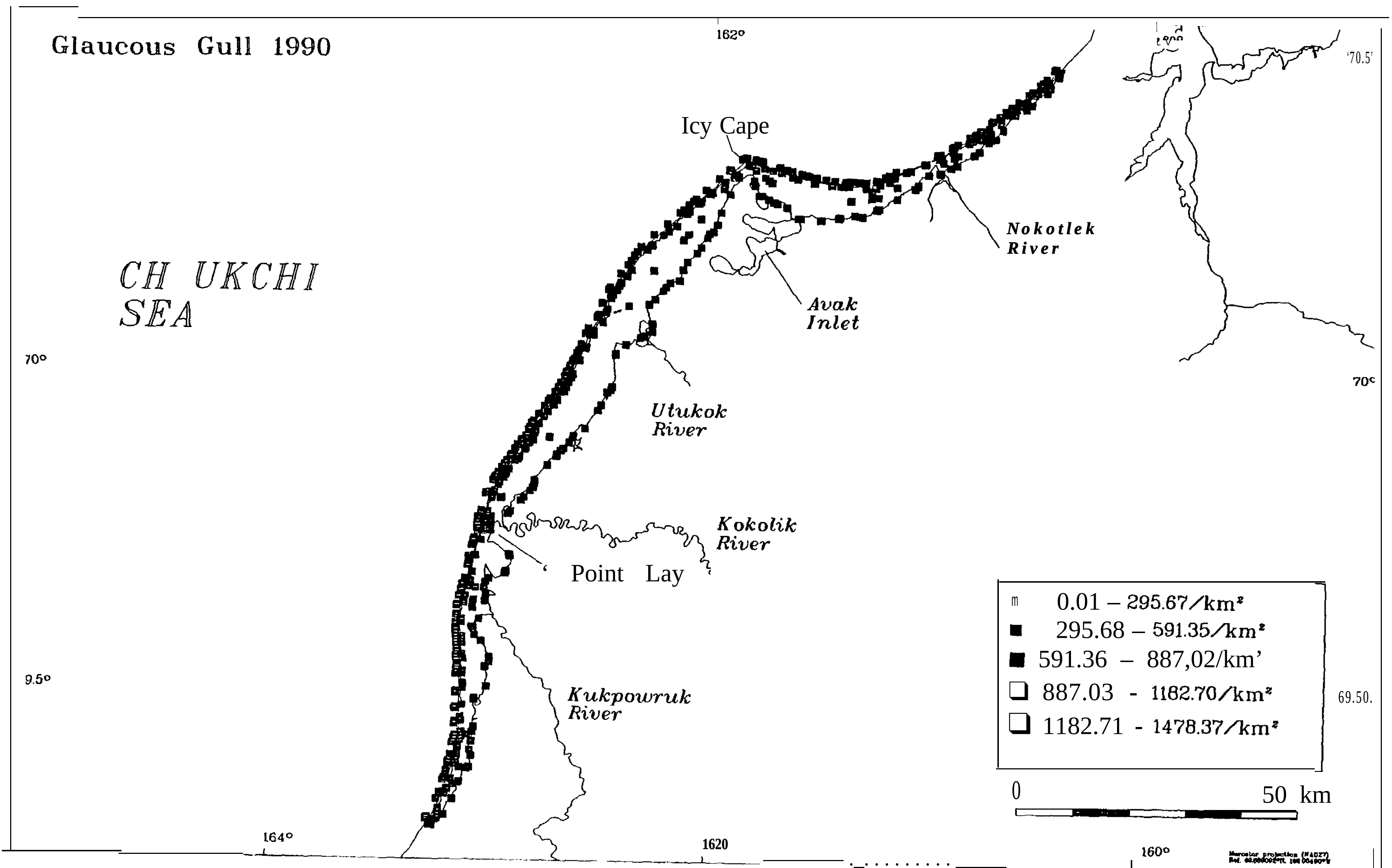


Figure 13. Summary of densities of glaucous gulls on l-minute transect segments in the Kasegaluk Lagoon study area in 1990.

Table 8. Habitat associations of glaucous gulls during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine	83	9.1	166	7.3
Ocean Beach	276	30.3	458	20.1
Ocean Surf	17	1.9	163	7.1
Lagoon	363	39.9	1084	47.5
Lagoon-Mainland margin*	73	8.0	46	2.0
Mid-Lagoon*	42	4.6	77	3.4
Lagoon-Island margin*	171	18.8	796	34.9
Lagoon Pass*	77	8.5	165	7.2
Shoal/Spit	2	0.2	43	1.9
River Delta	6	0.7	5	0.2
Pond/Lake on Tundra	13	1.4	16	0.7
Tundra	48	5.3	137	6.0
Coastal Marsh	18	2.0	20	0.9
Mudflat	84	9.2	187	8.2
River			1	0.0
Stream			2	0.1
All Habitats	910	100.0	2282	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category "Lagoon".

Waterfowl

Waterfowl were the largest single group of birds recorded in the study area in 1989 and 1990. Seventeen species or species groups of waterfowl were recorded during the five surveys in 1989 and 18 species or species groups were recorded during the eight surveys in 1990. Of the total 10,490 sightings and nearly a half million (422,614) individual birds seen on- and off-transect during 1989 and 1990, the largest proportion (4,892 or 46.6% of sightings; 345,507 or 81.8% of individuals) were waterfowl (Tables 2 and 3). In 1989 the proportion of individuals of waterfowl relative to all birds seen was 95.1% and in 1990 the proportion was 69.1%. Two species of geese (black brant and greater white-fronted goose) and two species of ducks (oldsquaw and common eider) dominated this group (Tables 2-4).

Black Brant (Branta bernicla nigracans)

The black brant was the most abundant species of bird recorded during aerial surveys in both 1989 and 1990. In 1989 there were 543 sightings (16.7% of all 1989 sightings) of 143,918 brant (70.2% of all birds in 1989), and in 1990 there were 858 sightings (11.870) of 82,906 brant (38.170). No other species was as abundant during this study (Tables 2-4).

Brant often flushed well ahead of the survey aircraft and it was sometimes difficult to determine whether they were actually on- or off-transect when first sighted. Also, it is possible that some individuals or flocks flew to adjacent as-yet-unsurveyed habitats and were counted more than once during a single day of aerial surveys. We do not think this happened often in 1989 when most brant were sedentary and were concentrated along a relatively small stretch of the mainland shoreline. But in 1990, when many brant (and other geese) appeared to be distributed more widely, the possibility of repeat counts may have been more problematic. It was not possible to quantify these sampling biases in either year of surveys. For this reason most results for black brant are presented as totals of on- plus off-transect individuals, and distribution maps of these geese show linear densities rather than areal densities.

The temporal patterns of brant abundance in the study area were quite different during the two years of surveys. In 1989 the peak of brant abundance

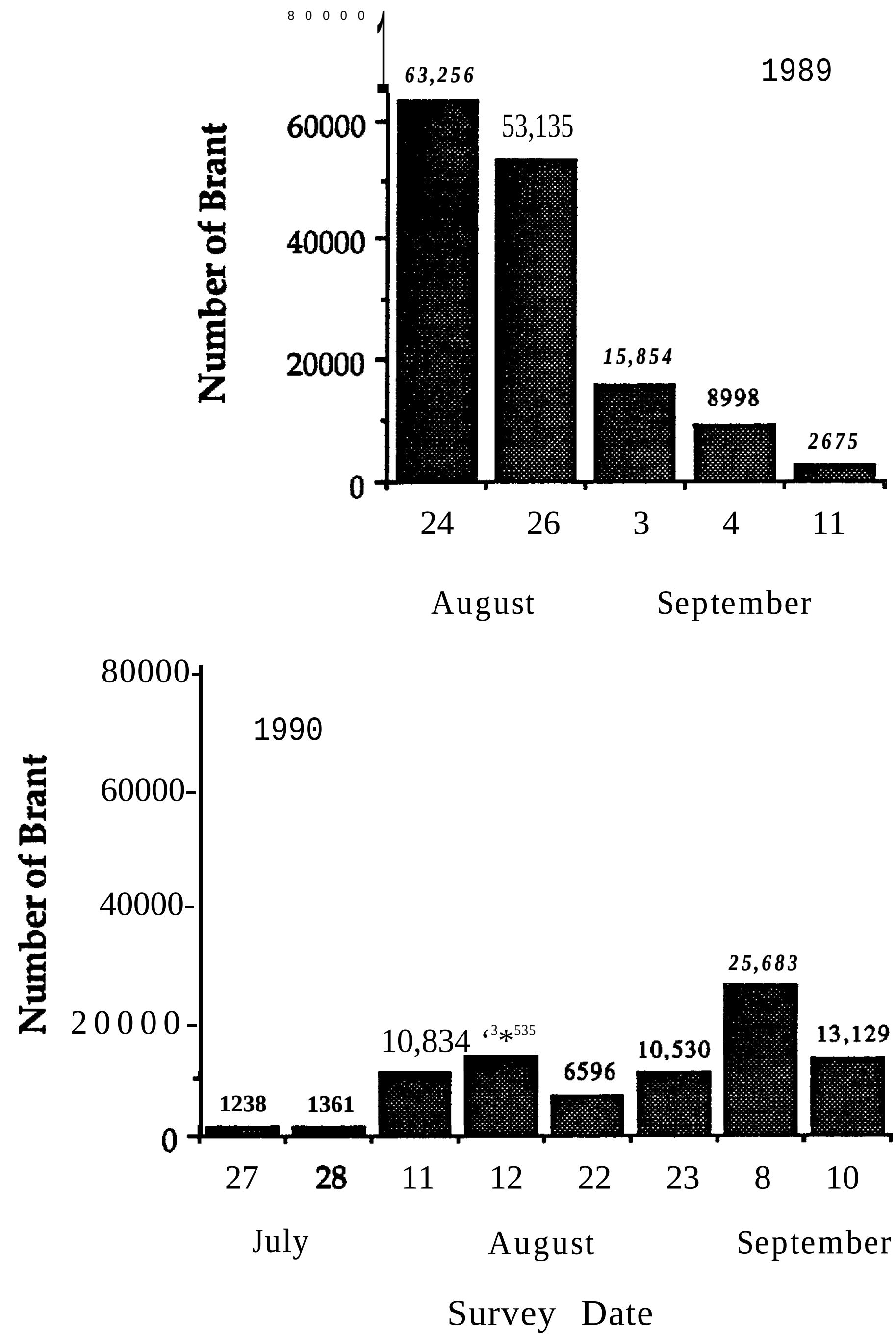


Figure 14. Total number of black brant seen both on-transect and off-transect on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

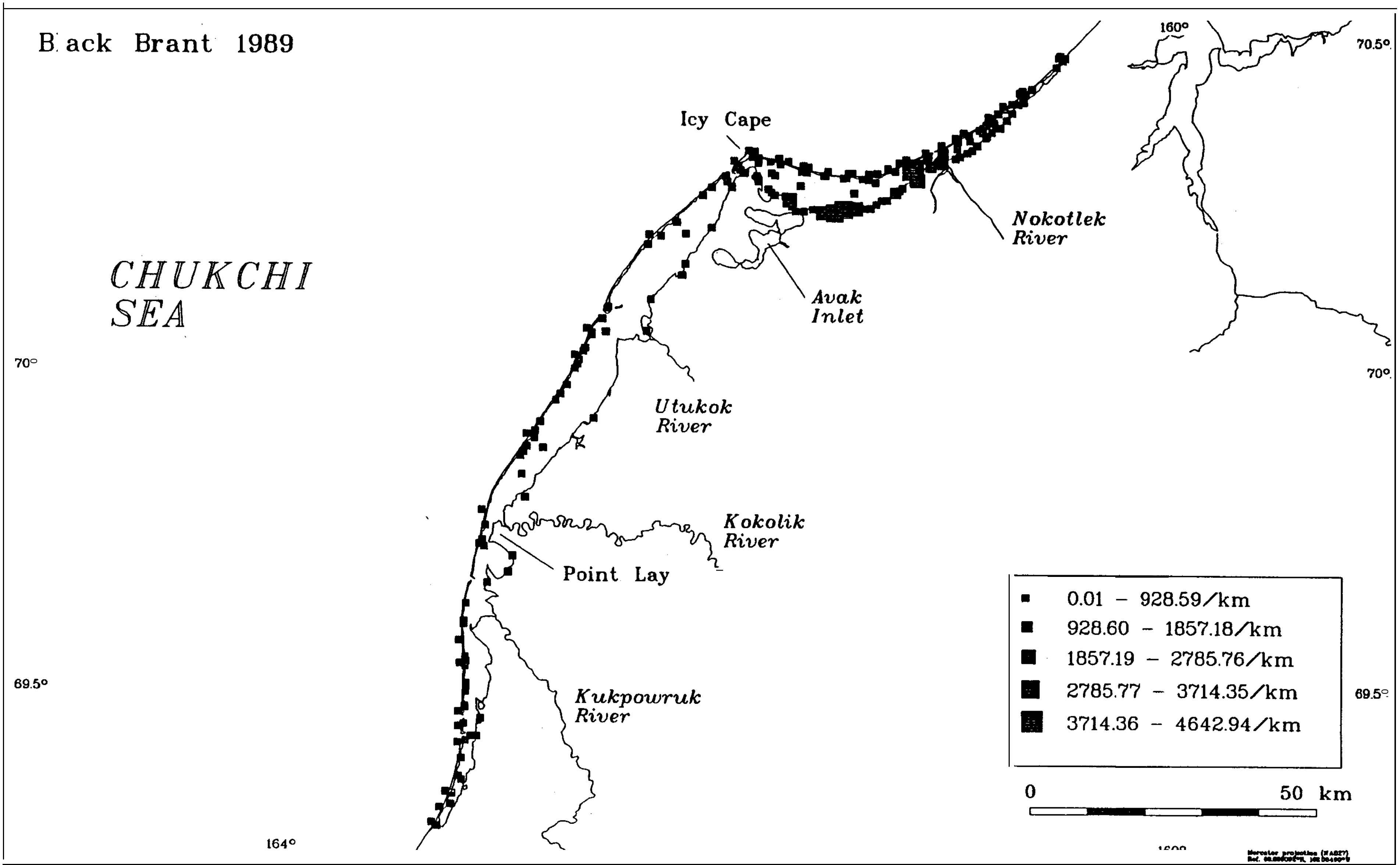


Figure 15. Summary of densities of black brant on 1-minute transect segments in the Kasegaluk Lagoon study area in 1989.

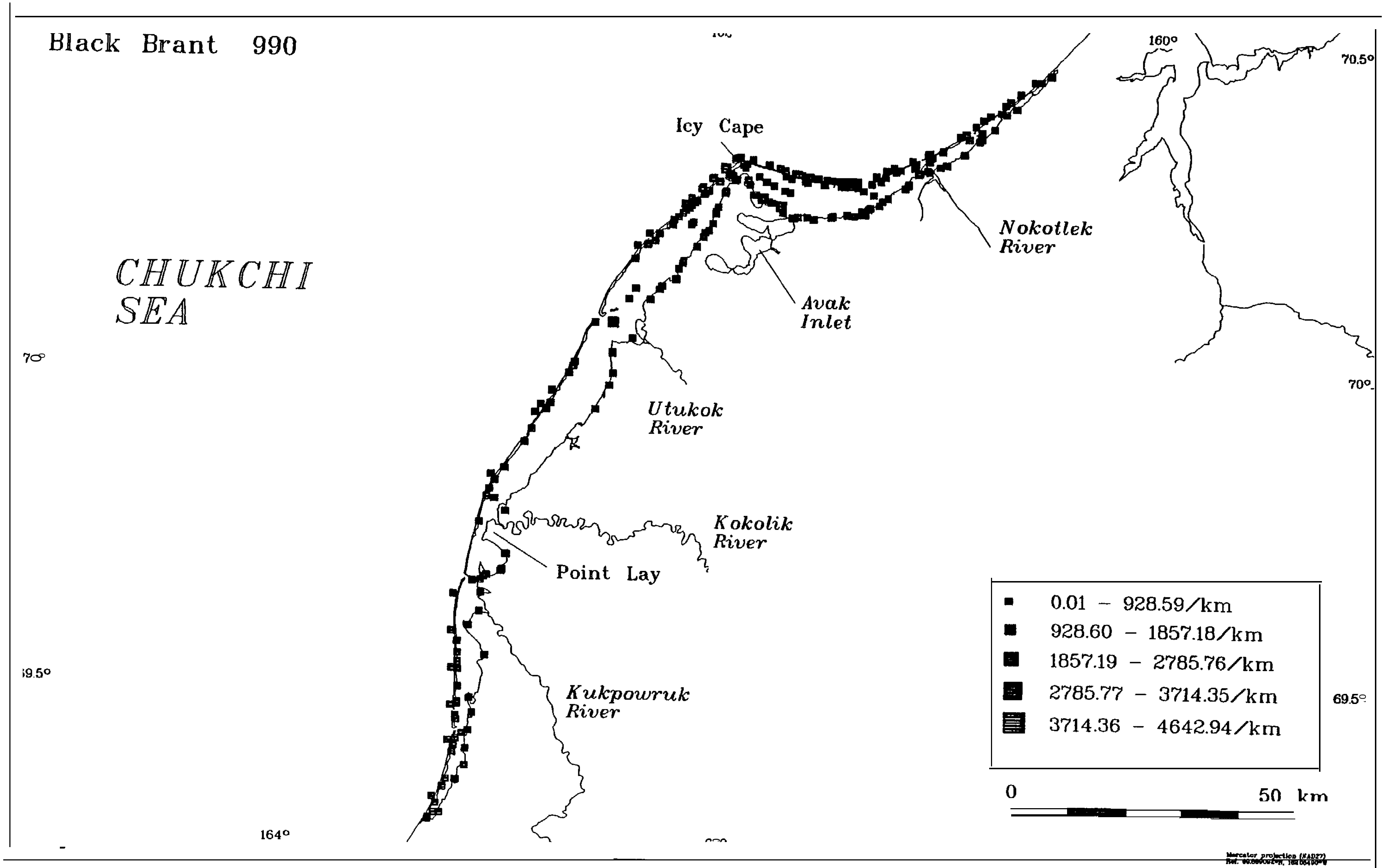


Figure 16. Summary of densities of black brant on 1-minute transect segments in the Kasegaluk Lagoon study area in 1990.

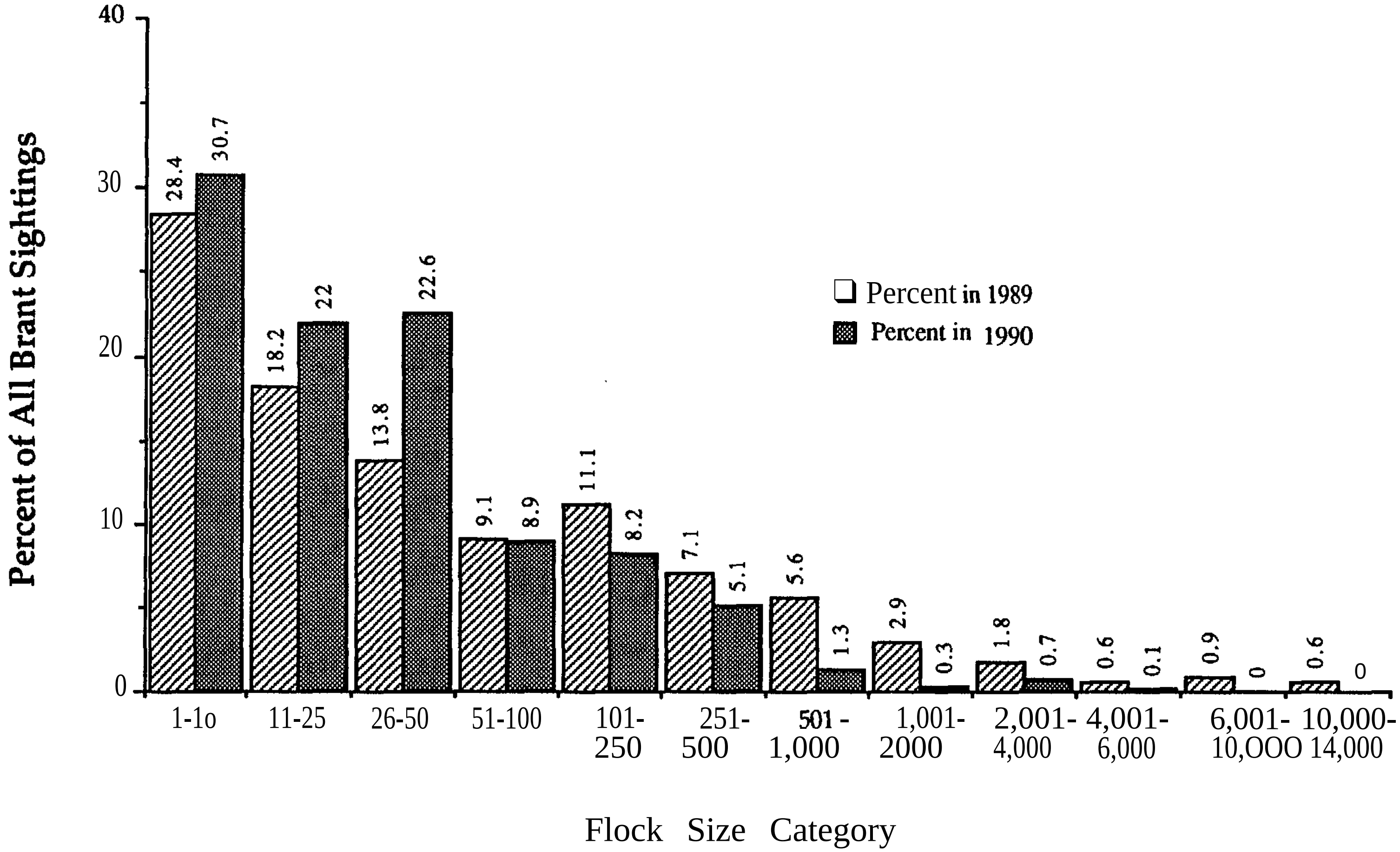


Figure 17. Summary of flock sizes of brant recorded in the Kasegaluk Lagoon study area in 1989 and 1990.

Table 9. Habitat associations of brant during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine	64	11.8	16	1.9
Ocean Beach	24	4.4	367	42.8
Ocean Surf	23	4.2	34	4.0
Lagoon	389	71.6	318	37.1
Lagoon-Mainland margin*	166	30.6	43	5.0
Mid-Lagoon”	62	11.4	38	4.4
Lagoon-Island margin*	161	29.7	237	27.6
Shoal/Spit	1	0.2	4	0.5
River Delta			3	0.3
Pond/Lake on Tundra			7	0.8
Tundra	30	5.5	45	5.2
Coastal Marsh	5	0.9	15	1.7
Mudflat	7	1.3	46	5.4
River				
Stream			3	0.3
All Habitats	543	100.0	858	100.0

An asterisk (“) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

was during the first set of aerial surveys on 24 and 26 August; most birds had migrated out of the study area by 11 September (Fig. 14). In 1990, on the other hand, peak numbers of brant were recorded during the last set of aerial surveys on 8 and 10 September (Fig. 14).

The spatial distribution of brant was similar during both years of surveys. Most sightings were in the northeastern section of Kasegaluk Lagoon, east and northeast of Ice Cape. In 1989 most sightings were on or adjacent to the section of transect 1101 between Nokotlek Point and the entrance to Avak Inlet (Fig. 15). In 1990 brant were distributed more widely in both barrier island and mainland shoreline habitats SW as well as E and NE of Icy Cape (Fig. 16, Append. B-5). The peak linear densities of brant (3360 to 4643 brant / linear km) recorded during l-minute transect segments were on 24 August 1989 in the area between Nokotlek Point and Icy Cape, where at least 56,350 brant were recorded on just one transect (transect 1102) on this date. In 1989 a few flocks of brant in this area were estimated to be well over 10,000 birds; flocks were smaller in 1990 (Fig. 17).

Habitat analyses indicated that about 70% of brant sightings in 1989 were in lagoon habitats, mainly along the mainland-lagoon margin and the barrier island-lagoon margin (Table 9). A relatively large proportion of sightings in 1989 (1 1.8%) were also recorded seaward of the barrier islands, in nearshore marine (ocean) habitats. In 1990 a markedly smaller proportion of brant sightings were recorded in lagoon habitats, and a corresponding larger proportion (42.8% in 1990 compared to 4.2% in 1989) were recorded along beaches on the seaward sides of the barrier islands (Ocean Beach; Table 9).

Greater White-fronted Goose (Anser *albifrons frontalis*)

The greater white-fronted goose was the second most abundant goose recorded in the study area in both years of surveys. In contrast to the situation described for brant, far more white-fronted geese were recorded in the study area in 1990, when a full complement of aerial surveys was conducted. This species represented 1.570 (49) of all bird sightings and 0.6% (1329) of all individual birds recorded in 1989, and 2.6% (187) of all sightings and 4.6% (10,098) of all individual birds recorded in 1990 (Tables 2-4).

The temporal patterns of abundance indicated that most white-fronted geese were present in the study area until late August or early September in

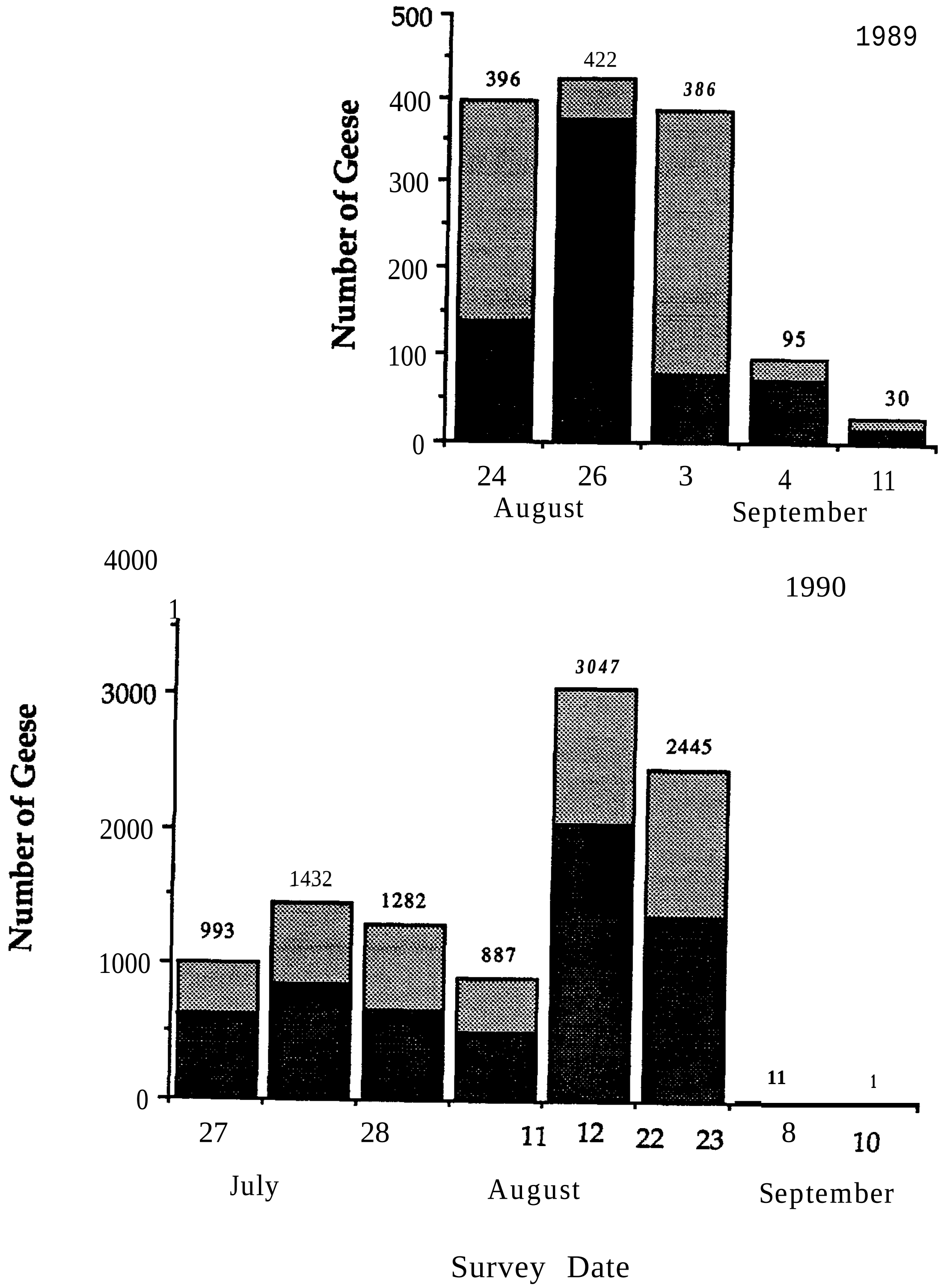


Figure 18. Total number of greater white-fronted geese seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

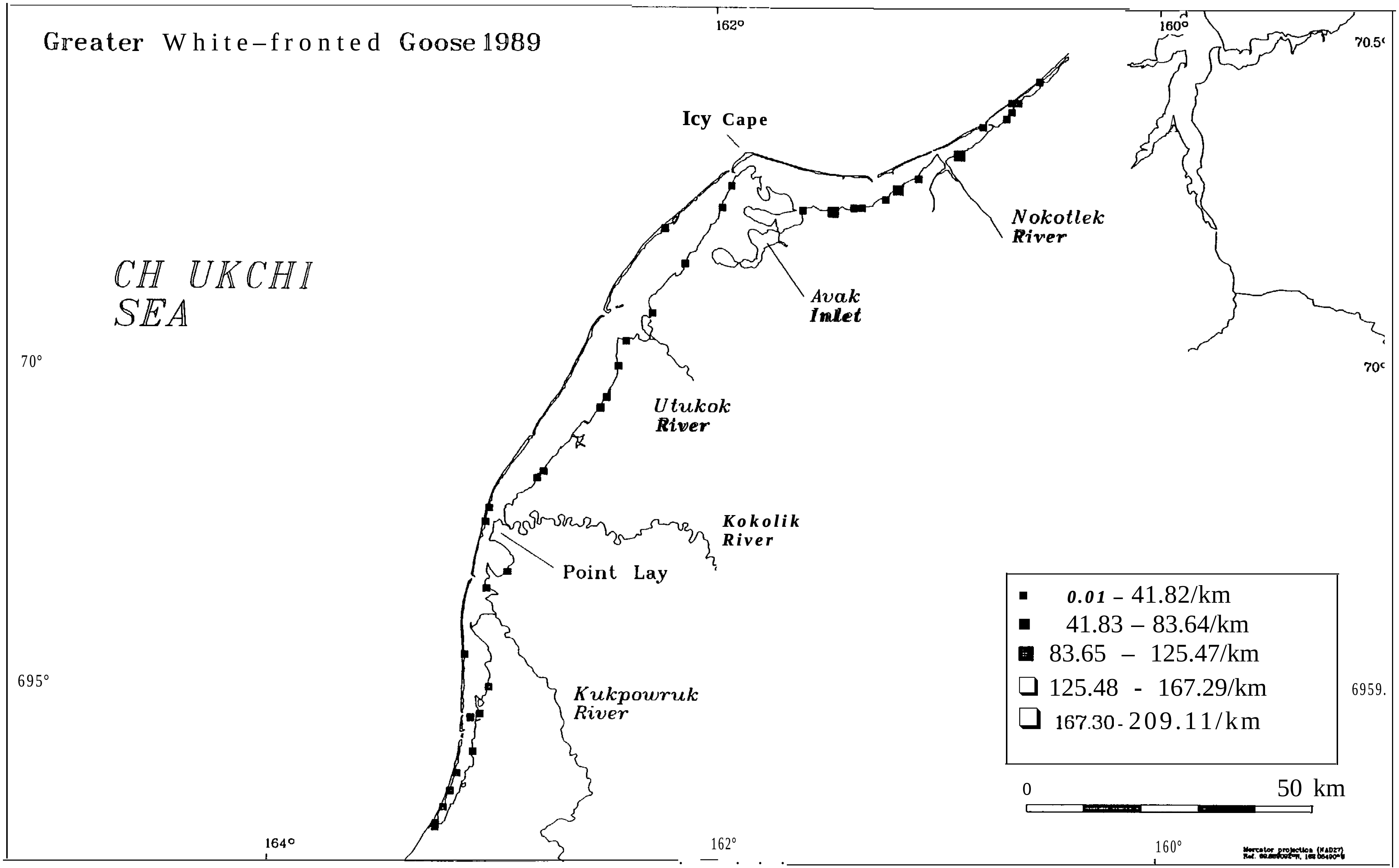


Figure 19. Summary of densities of greater white-fronted geese on l-minute transect segments in the Kasegaluk Lagoon study area in 1989.

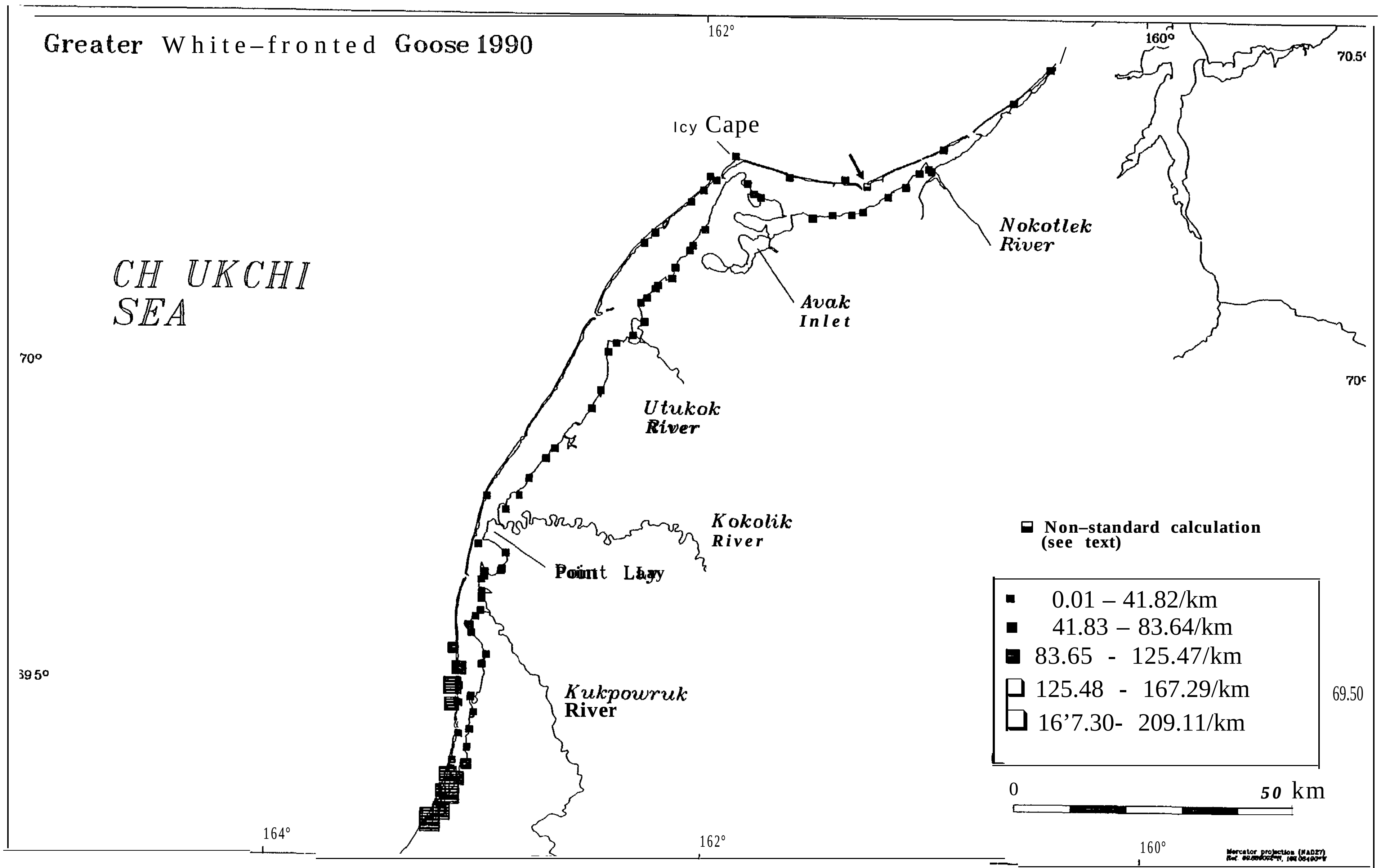


Figure 20. Summary of densities of greater white-fronted geese on l-minute transect segments in the Kasegaluk Lagoon study area in 1990.

Table 10. Habitat associations of greater white-fronted geese during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine				
Ocean Beach	1	2.0	15	8.0
Ocean Surf			1	0.5
Lagoon	18	36.7	50	26.7
Lagoon-Mainland margin*	8	16.3	6	3.2
Mid-Lagoon*			4	2.1
Lagoon-Island margin”	10	20.4	40	21.4
Shoal/Spit				
River Delta			2	1.1
Pond/Lake on Tundra	3	6.1	19	10.2
Tundra	20	40.8	84	44.9
Coastal Marsh	6	12.2	8	4.3
Mudflat			7	3.7
River			1	0.5
Stream	1	2.0		
All Habitats	49	100.0	187	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

both 1989 and 1990. The peak of migration out of the Kasegaluk Lagoon area during both years appeared to be in the last week of August and first week of September (Fig. 18).

The spatial distribution of greater white-fronted geese was quite different during the two years of surveys. In 1989 the highest linear densities of this species were in the northeastern part of the study area — northeast of Icy Cape (Fig. 19). The highest linear density recorded on a l-minute transect segment (80.5 geese/km) in 1989 was on transect 1101 near the mouth of the Nokotlek River on 3 September (Append. B-6). In contrast, the highest densities of white-fronts recorded in 1990 were in the coastal marshes at the extreme southwestern end of the study area (Fig. 20). Peak densities (150-200 geese/linear km) on l-minute transect segments in these areas were on transects 1106 and 1301 on 22 and 23 August 1990 (Append. B-6).

Habitat analyses indicated that over 40% of white-fronted goose sightings in both 1989 and 1990 were on mainland tundra habitats (Table 10). Relatively large proportions of sightings in both years (36.7% and 26.7% in 1989 and 1990, respectively) were also recorded in lagoon habitats, mainly along the barrier island-lagoon margin (20.4% and 21.470, respectively; Table lo).

Lesser Snow Goose (*Chen caerulescens caerulescens*)

Lesser snow geese were seen in the study area in both 1989 and 1990. In 1989 there were 8 sightings of 166 snow geese and during 1990 there were 23 sightings of 1033 snow geese (Tables 2-4). They represented less than 0.6% of both all sightings and all birds recorded in each of the two years. Only fully fledged snow geese were recorded in 1989 when surveys began in late August, but some individuals were clearly recognizable (grey plumage) as young-of-the-year. In 1990, however, when a full complement of aerial surveys were conducted, flightless (molting) adults with half-grown goslings were recorded during the July surveys. The presence of goslings at specific locations indicated that snow geese probably nested in the Kasegaluk Lagoon area.

The spatial distribution of lesser snow geese in the two years of surveys was very similar. In both 1989 and 1990 the densities of lesser snow geese were highest at two locations: on transect 1102 in the area near the entrance to Avak Inlet (about 11 birds/linear km), and on transect 1105 near the delta of

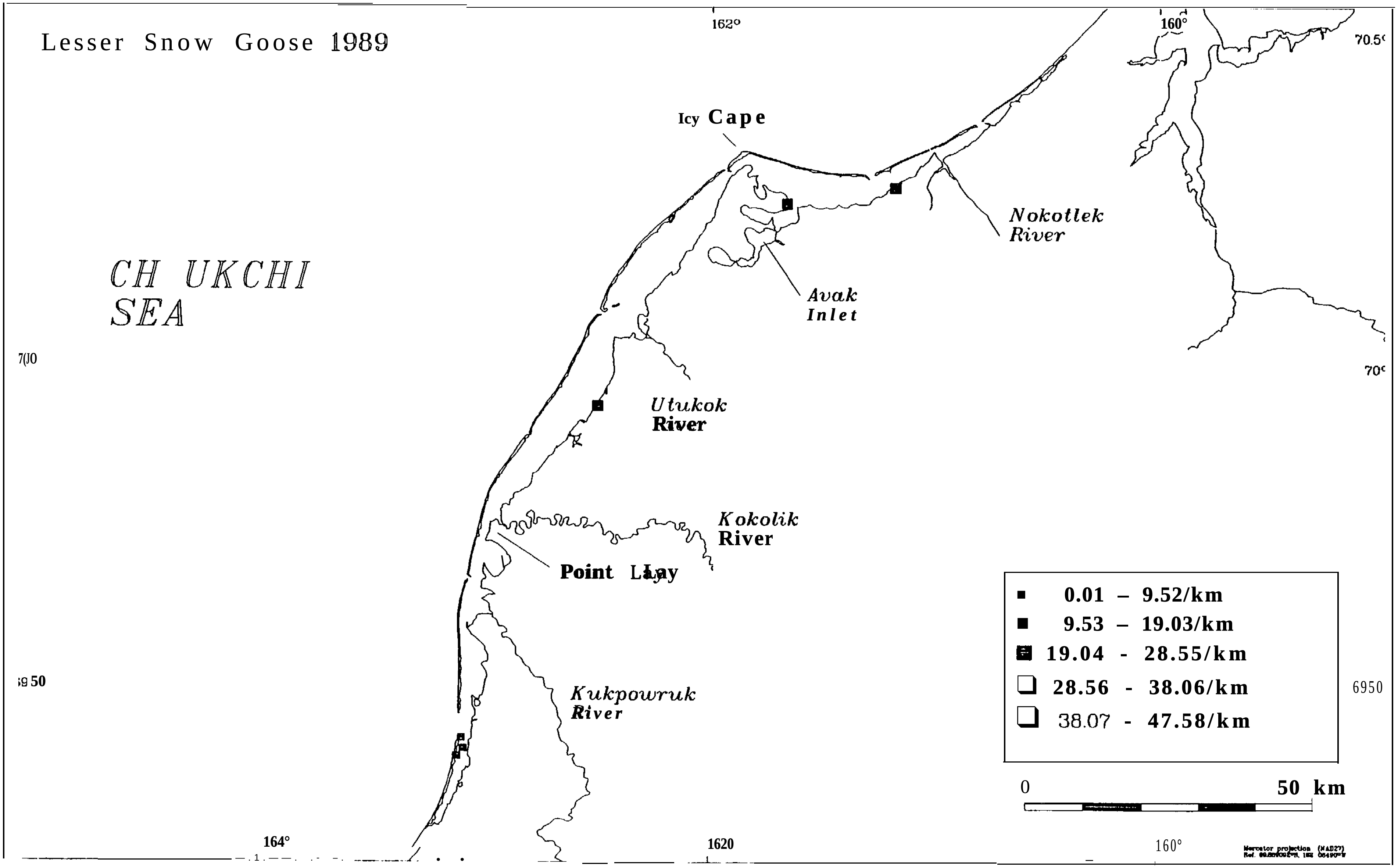


Figure 21. Summary of densities of lesser snow geese on l-minute transect segments in the Kasegaluk Lagoon study area in 1989.

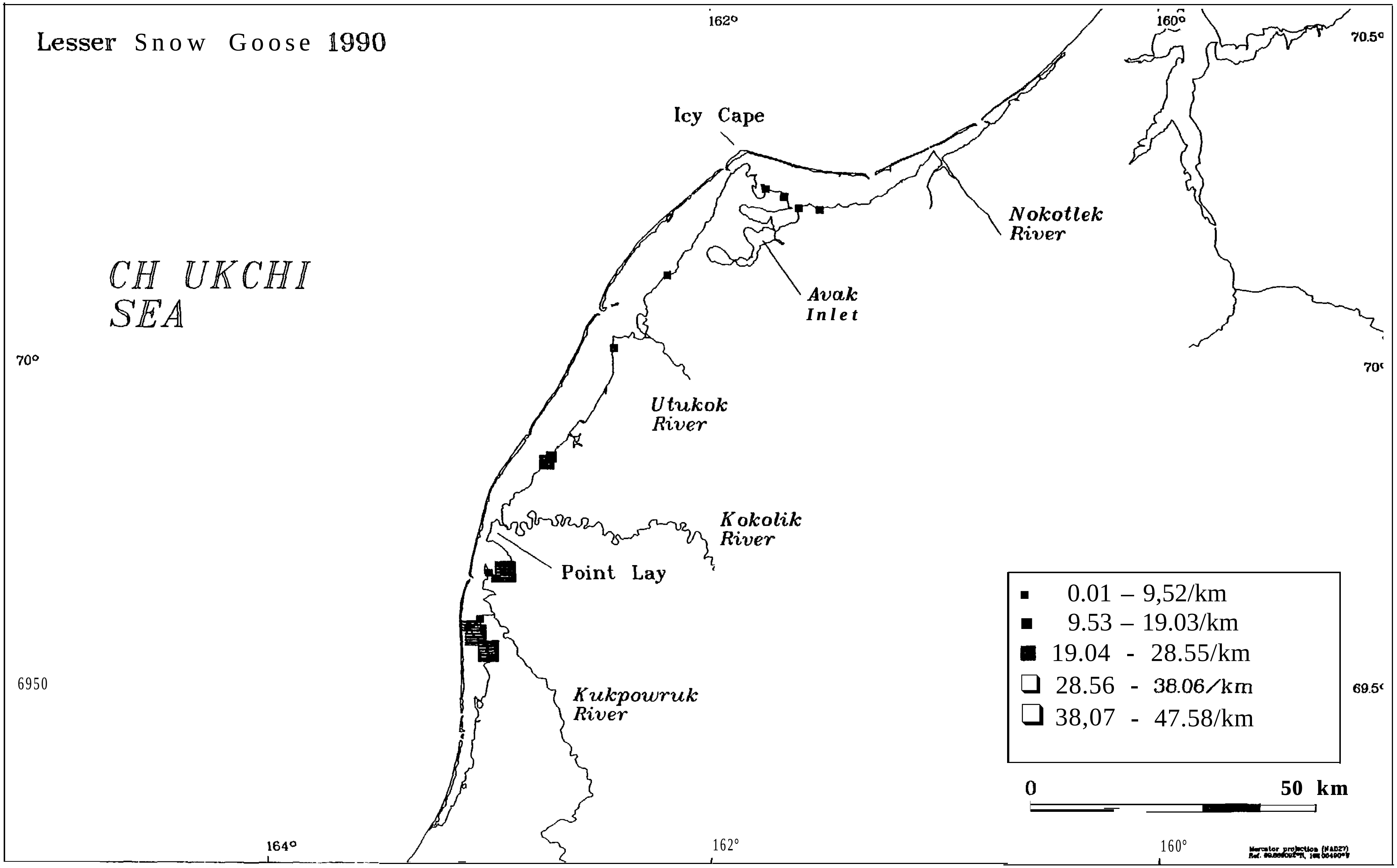


Figure 22. Summary of densities of lesser snow geese on l-minute transect segments in the **Kasegaluk** Lagoon study area in 1990.

Table 11. Habitat associations of lesser snow geese during aerial surveys of **Kasegaluk** Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine				
Ocean Beach				
Ocean Surf				
Lagoon	5	62.5	5	21.7
Lagoon-Mainland **margin***	2	25.0	5	21.7
Mid-Lagoon*	1	12.5		
Lagoon-Island margin”	2	25.0		
Shoal/Spit				
River Delta				
Pond/Lake on Tundra			7	30.4
Tundra	3	37.5	11	47.8
Coastal Marsh				
Mud flat				
River				
Stream				
All Habitats	8	100.0	23	100.0

An asterisk (“) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

the Kukpowruk River (about 48 birds/linear km; Figs. 21 and 22, Append. B-7).

Habitat analyses indicated that in 1989, when most snow geese were capable of flight, they were associated with lagoon habitats (62.5% of all sightings), primarily the mainland-lagoon margin and the barrier island-lagoon margin (Table 11). In 1990, on the other hand, family groups of snow geese were mainly associated with mainland tundra habitat (47.8% of all sightings) and with lakes and ponds (30.4%) along the mainland coast. Only 21.7% of all snow goose sightings in 1990 were in lagoon habitats (Table 11).

Tundra Swan (*Cygnus columbianus*)

Tundra swans were seen in the study area in both 1989 and 1990. In 1989 there were 28 sightings of 71 tundra swans and in 1990 there were 46 sightings of 138 swans. They represented 0.9% of all sightings and less than 0.1% of all birds in 1989, and 0.6% of all sightings and 0.1% of all birds in 1990 (Tables 2-4). Family groups, including flightless young-of-the-year, were seen during surveys in 1990, indicating that they nested in the Kasegaluk Lagoon area in that year.

The temporal patterns of abundance of tundra swans were similar during comparable periods in the two years of surveys. Peak numbers were seen in the study area in late August in both years, but the overall number of swans present in the study area during the last survey in 1990 was greater than on the last survey in 1989 (Fig. 23).

The spatial distribution of tundra swans in the two years of surveys was very similar. In both 1989 and 1990 the linear densities of tundra swans were highest at two locations: in the marshes adjacent to transect 1301 at the extreme SW end of the study area, and on mainland transect 1103, adjacent to the Utukok River delta. The peak linear density recorded on a l-minute transect segment (4.43 swans/linear km) was recorded near the start of transect 1301 on 26 August 1989, and linear densities ranging from 1.20 to 3.15 swans/linear km of transect surveyed were recorded along transect 1103 in both 1989 and 1990 (Figs. 24 and 25, Append. B-8).

Habitat analyses indicated that in 1989 tundra swans were associated mainly with ponds and lakes along the mainland coast (42.9910 of all sightings in 1989), and with coastal marsh habitats (35.7% of all sightings; Table 12). In

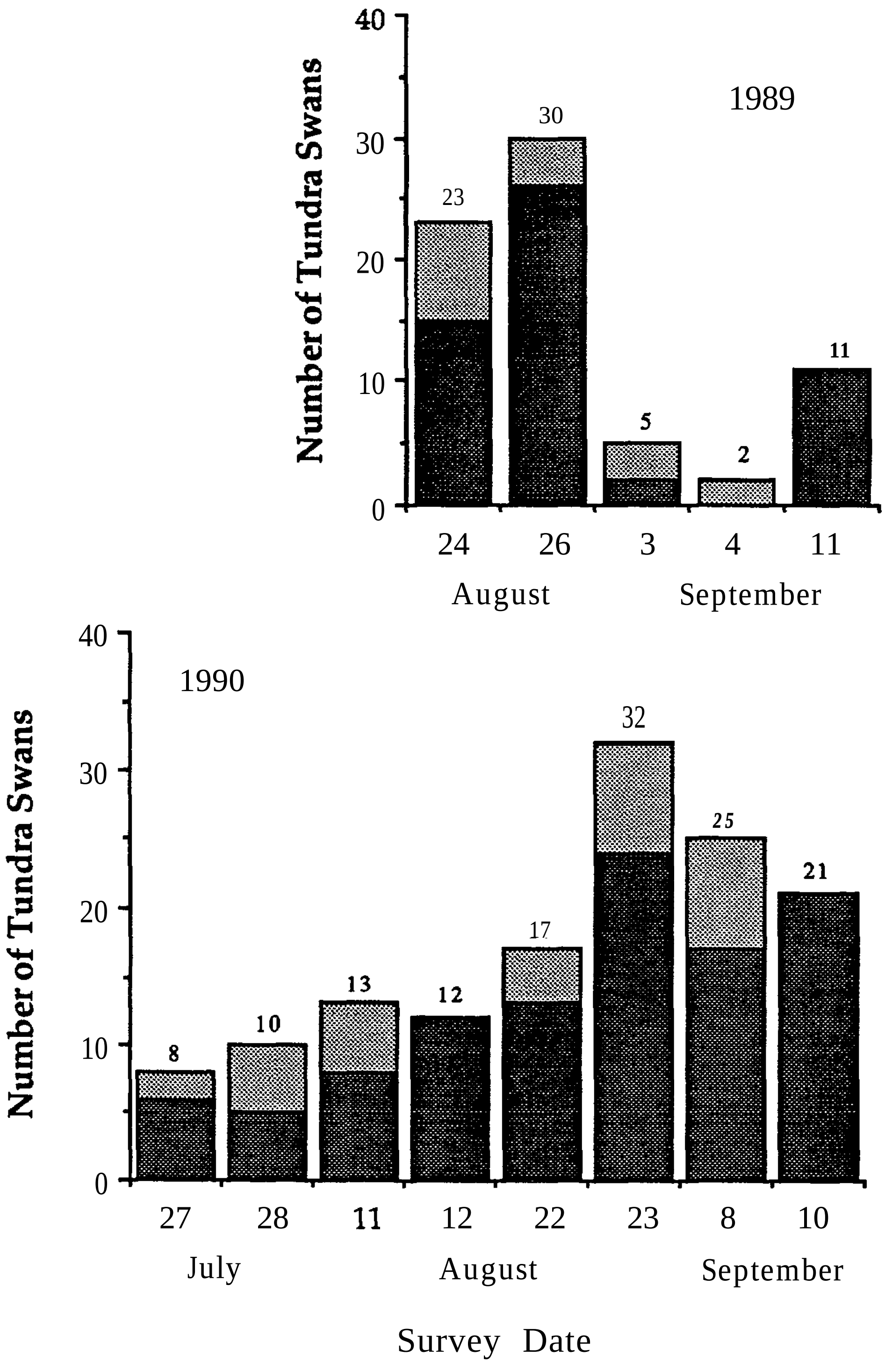


Figure 23. Total number of tundra swans seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

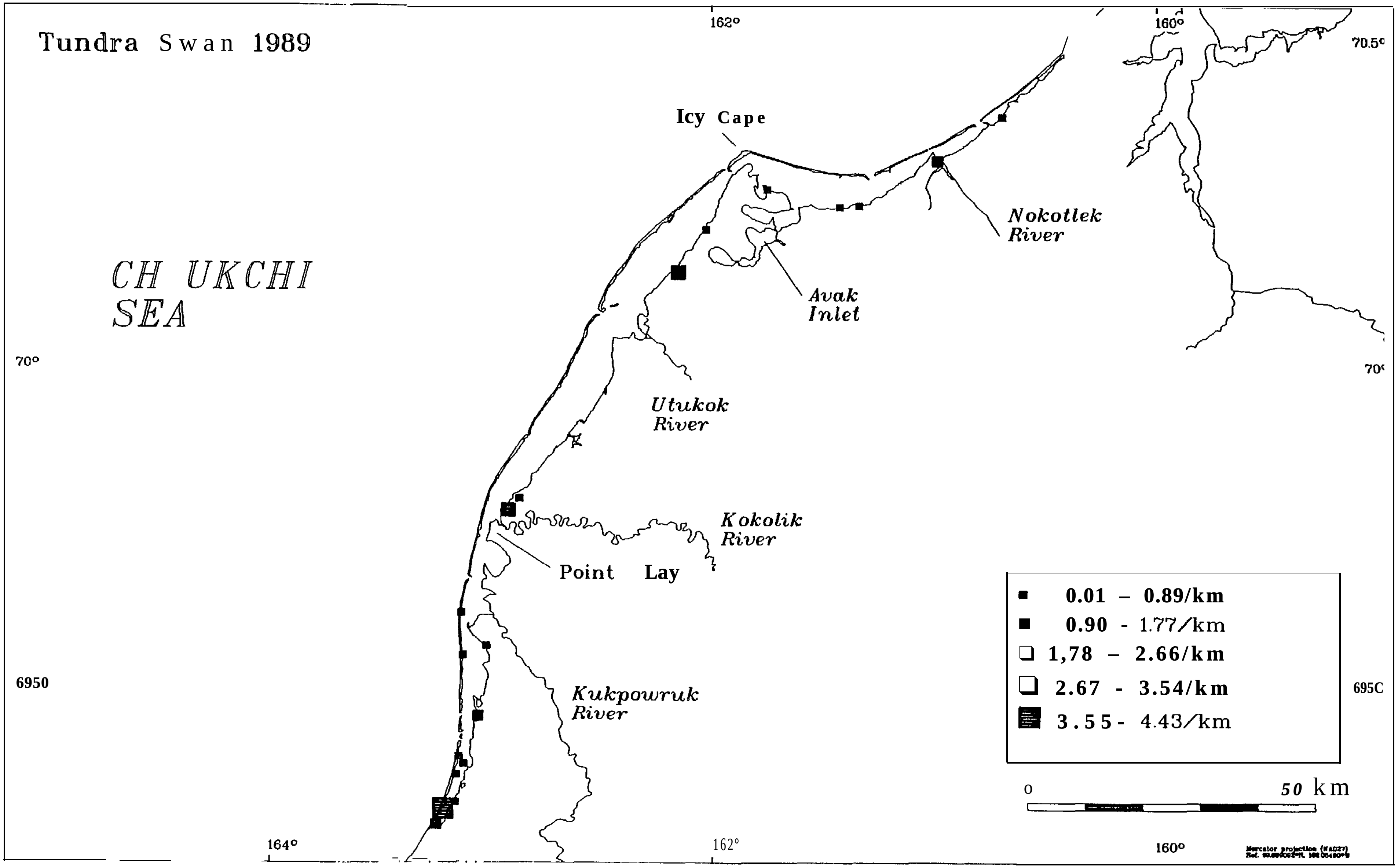


Figure 24. Summary of densities of tundra swans on l-minute transect segments in the **Kasegaluk** Lagoon study area in 1989.

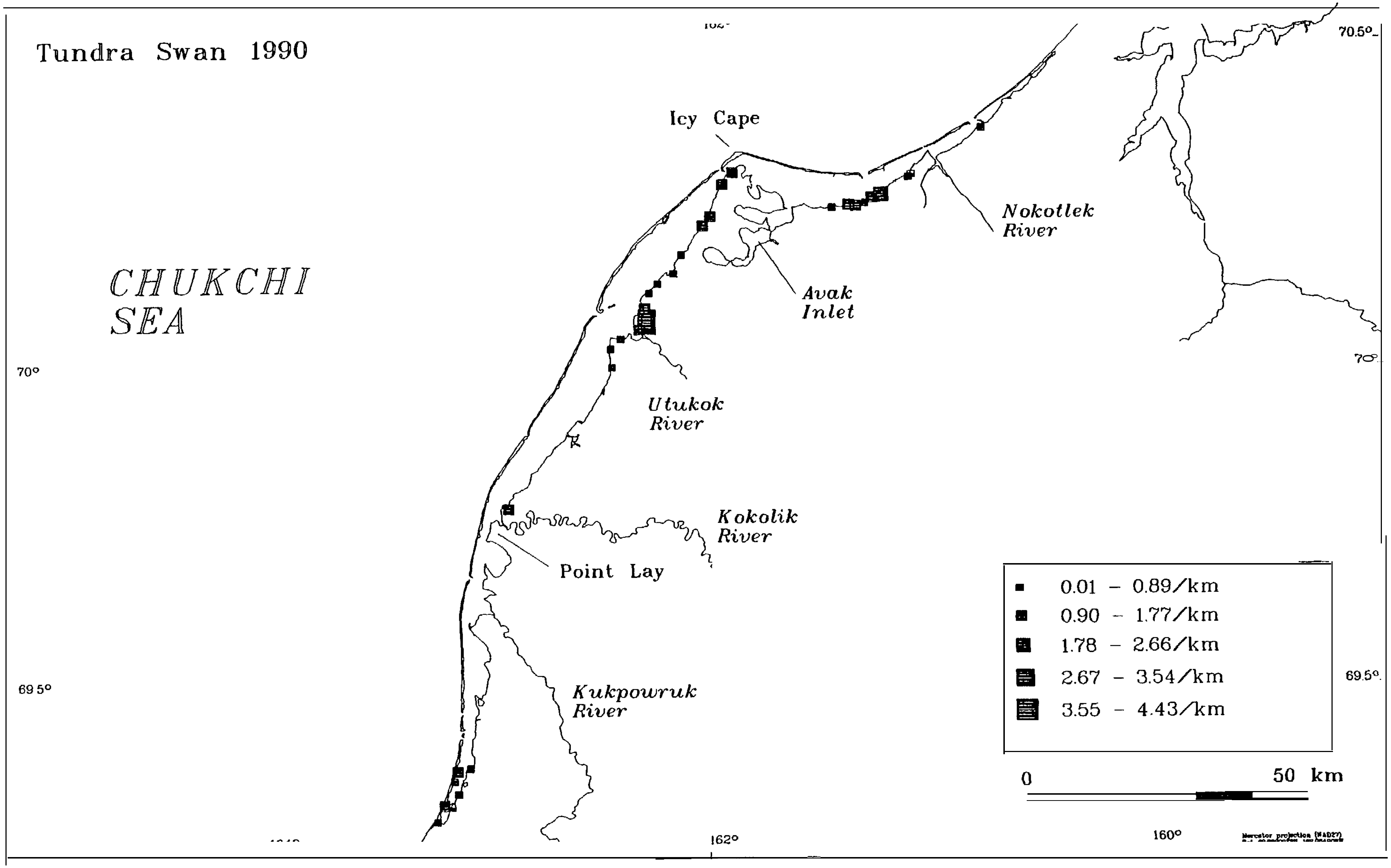


Figure 25. Summary of densities of tundra swans on 1-minute transect segments in the Kasegaluk Lagoon study area in 1990.

Table 12. Habitat associations of tundra swans during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989		1990	
	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total
Ocean-Nearshore Marine				
Ocean Beach	1	3.6	2	4.3
Ocean Surf			1	2.2
Lagoon	3	10.7	7	15.2
Lagoon-Mainland margin*	1	3.6	6	13.0
Mid-Lagoon*	1	3.6		
Lagoon-Island margin*	1	3.6	1	2.2
Shoal/Spit				
River Delta			2	4.3
Pond/Lake on Tundra	12	42.9	26	56.5
Tundra	2	7.1	3	6.5
Coastal Marsh	10	35.7	3	6.5
Mudflat				
River			1	2.2
Stream			1	2.2
All Habitats	28	100.0	46	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

1990, however, a larger proportion of tundra swan sightings were in lagoon habitats, mainly in the strip along the lagoon-mainland margin, especially in rivers deltas (Table 12, Fig. 25).

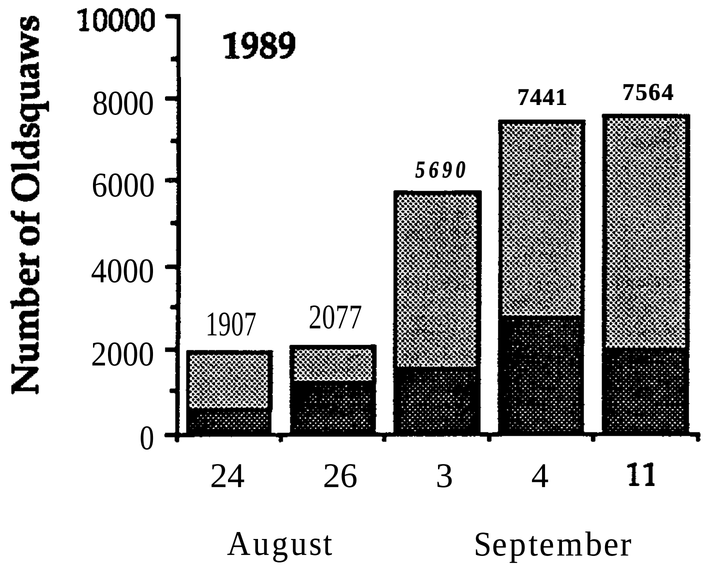
Oldsquaw (Clangula hyemalis)

The oldsquaw was the second most abundant species of waterfowl and the second most abundant species of bird recorded in the study area in the two years of aerial surveys. In 1989 there were 478 sightings (14.7% of all 1989 sightings) of 24,679 individuals (12.0% of all 1989 individuals), and in 1990 there were 796 sightings (11.0%) of 33,084 individuals (15.2%) recorded in the study area (Tables 2-4).

The temporal patterns of oldsquaw abundance were quite different in the two years of surveys. In 1989 large numbers of oldsquaws (7564 birds; 30.7% of all oldsquaws recorded in 1989) were still present in the study area during the last survey on 11 September (Fig. 26). In contrast, during 1990 the number of oldsquaws recorded during the final set of surveys on 8 and 10 September (collectively 2425 birds; 7.3% of all oldsquaws recorded in 1990) was greatly reduced from the number recorded during the previous set of surveys on 22 and 23 August (collectively 12,958 birds, 39.2%; Tables 2 and 3, and Figs. 27 and 28).

The spatial distribution of oldsquaws in both years of study was closely tied to lagoonside barrier island habitats, especially in the northeastern portion of Kasegaluk Lagoon (Figs. 27 and 28, Append. B-9). The portion of transect 1306 between Nokotlek Pass and Pingorarok Pass was heavily used by oldsquaws. The peak density on a l-minute transect segment was in this area on 23 August 1990 when about 1850 birds/sq km were recorded (Fig. 27).

Habitat analyses indicated that oldsquaws used similar habitats during both 1989 and 1990. In both years the largest proportion of all sightings were in lagoon habitats (87.4% in 1989 and 88.6% in 1990; Table 13). The mid-lagoon region and the barrier island-lagoon margin were the two lagoon habitats most frequently used in both years (Table 13).



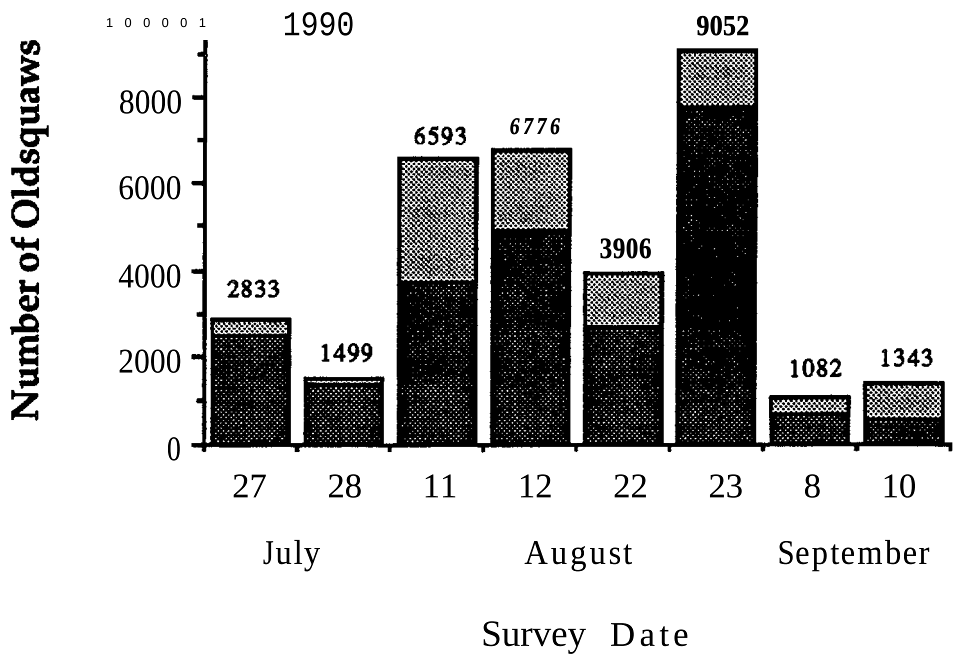


Figure 26. Total number of oldsquaws seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

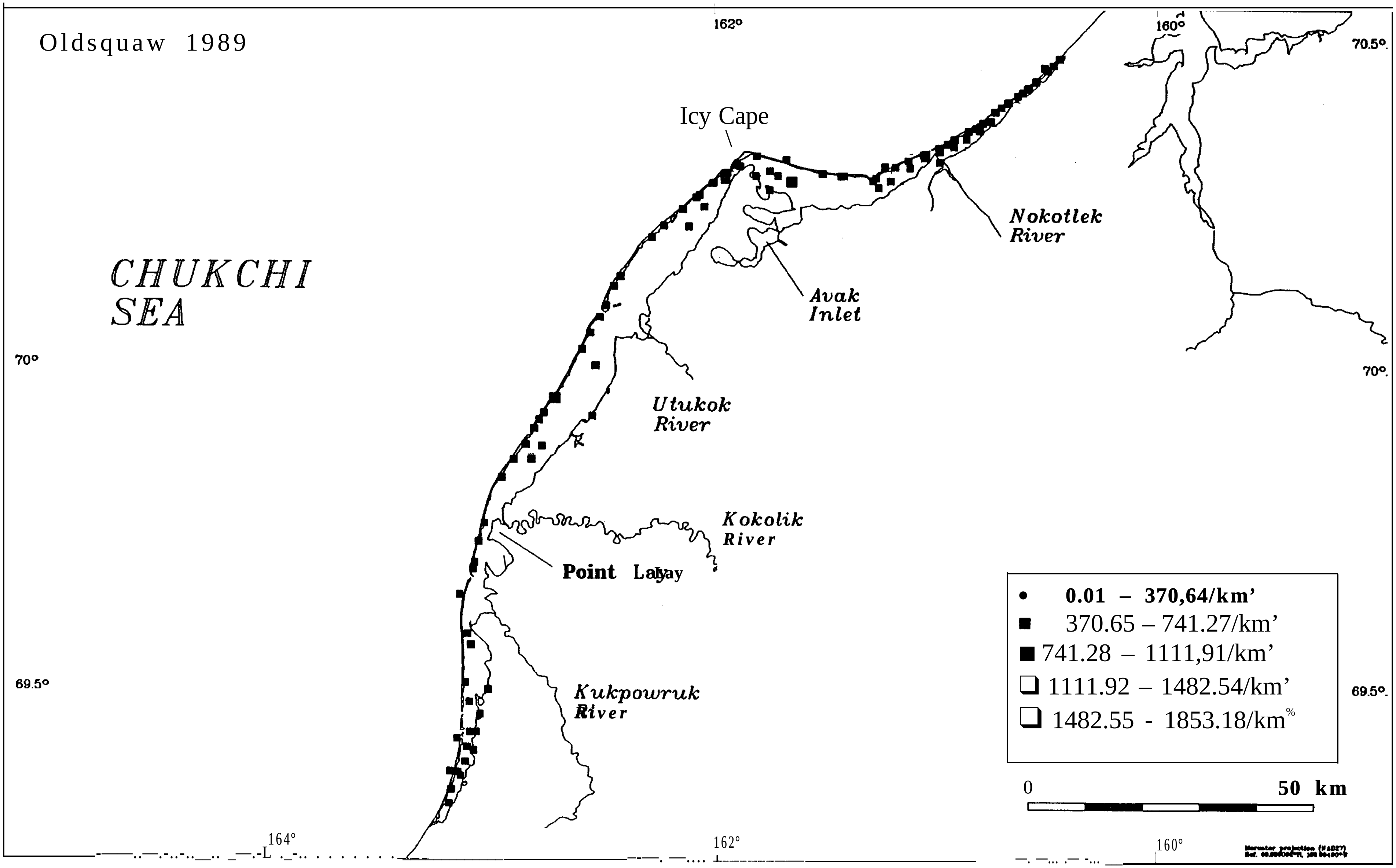


Figure 27. Summary of densities of oldsquaws on l-minute transect segments in the Kasegaluk Lagoon study area in 1989.

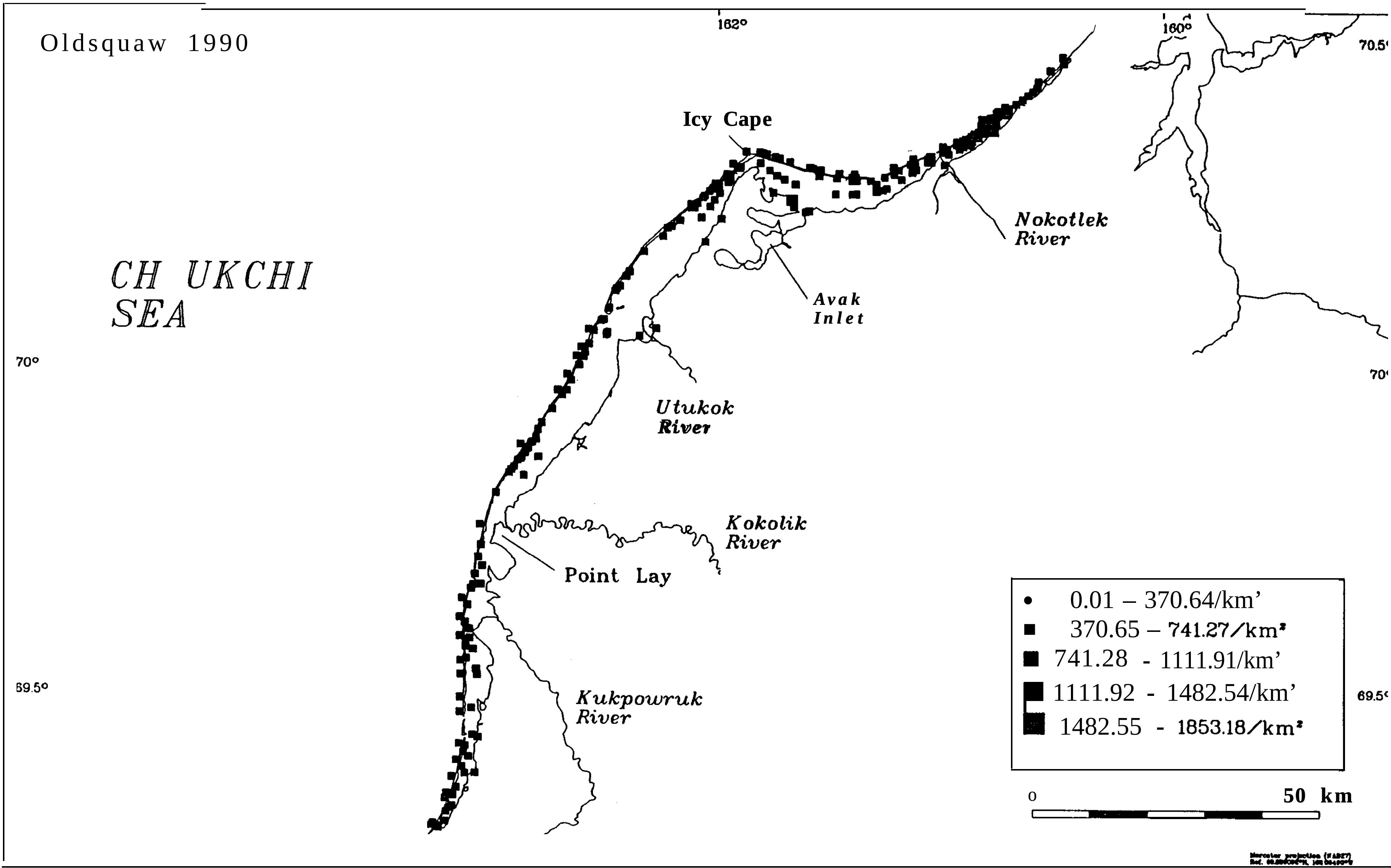


Figure 28. Summary of densities of oldsquaws on l-minute transect segments in the **Kasegaluk** Lagoon . study area in 1990.

Table 13. Habitat associations of oldsquaws during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 ‘Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine	44	9.2	51	6.4
Ocean Beach	7	1.5	7	0.9
Ocean Surf	3	0.6	5	0.6
Lagoon	418	87.4	705	88.6
Lagoon-Mainland margin*	41	8.6	9	1.1
Mid-Lagoon*	144	30.1	183	23.0
Lagoon-Island margin”	175	36.6	368	46.2
Lagoon Pass*	58	12.1	145	18.2
Shoal/Spit			3	0.4
River Delta			2	0.3
Pond/Lake on Tundra	3	0.6	11	1.4
Tundra				
Coastal Marsh	2	0.4	7	0.9
Mudflat	1	0.2	4	0.5
River				
Stream			1	0.1
All Habitats	478	100.0	796	100.0

An asterisk (“) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

Common Eider (*Somateria mollissima v-nigra*)

The common eider was a relatively abundant species of waterfowl in both 1989 and 1990. This species constituted 13.5% (437) of all bird sightings and 3.4% (7046) of all individuals recorded in 1989, and 8.4% (609) of all sightings and 3.0% (6540) of all individual birds recorded in 1990 (Tables 2-4).

The temporal patterns of common eider abundance were similar in 1989 and 1990. In 1989 relatively large numbers of eiders were seen on all surveys, with the peak number (2031 individuals) seen in early September. In 1990 peak numbers of common eiders were also observed in early September, but large numbers were also seen on 23 August and on both of the last two surveys, i.e., on 8 and 10 September 1990 (Fig. 29).

The spatial distribution of common eiders, like oldsquaws, was closely tied to lagoonside barrier island habitats, especially in the northeastern portion of Kasegaluk Lagoon (Figs. 30 and 31). The portions of transects 1304 near Icy Cape and transects 1305 and 1306 between Icy Cape and Pingorarok Pass were particularly heavily used by common eiders. The peak density in this area was on 11 September 1990 when over 700 eiders /sq km were recorded. The peak density in this area in 1989 was on 26 August when over 230 common eiders/sq km were recorded near Akoliakatat Pass (Fig. 30). During both years of surveys high densities of common eiders were recorded near Nokotlek Pass and Pingorarok Pass (Append. B-10).

Habitat analyses indicated that in both 1989 and 1990 common eiders were most closely associated with nearshore marine habitats in the Chukchi Sea and with lagoon-barrier island margin habitats (Table 14). In 1989 the association of common eiders with marine habitats was more obvious than in 1990 (53.5% of all sightings in 1989 vs. 30.4% in 1990). In contrast, the association of common eiders with lagoon-barrier island margin habitats was stronger in 1990 than in 1989 (47.6% of all sighting in 1990 vs. 22.2% of sightings in 1989; Table 14).

Other Diving Ducks

Two other species of diving ducks regularly recorded in the Kasegaluk Lagoon study area were the red-breasted merganser (*Mergus serrator*) and surf scoter (*Melanitta perspicillata*). The overall numbers of sightings and

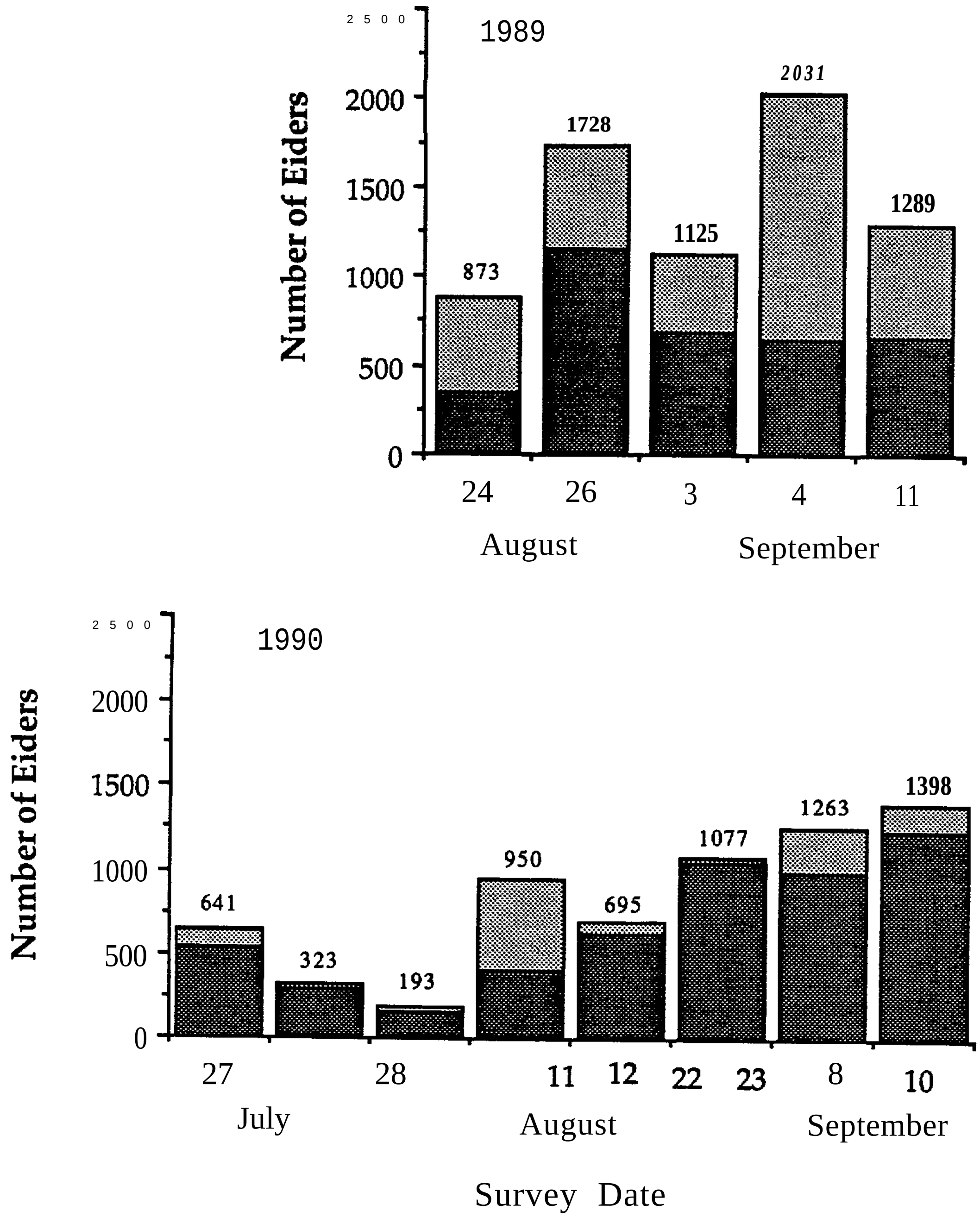


Figure 29. Total number of common eiders seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

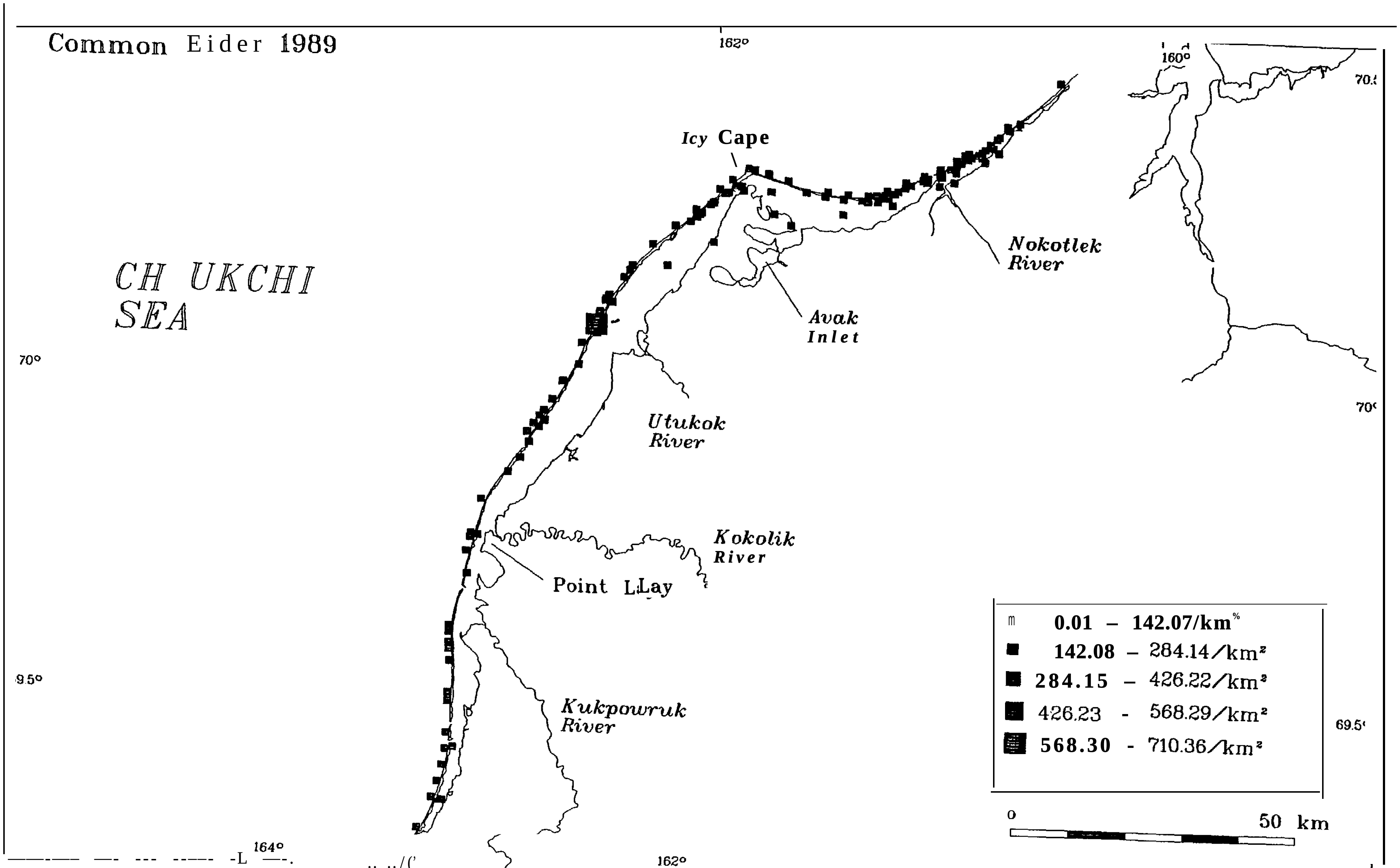


Figure 30. Summary of densities of common eiders on 1-minute transect segments in the Kasegaluk Lagoon study area in 1989.

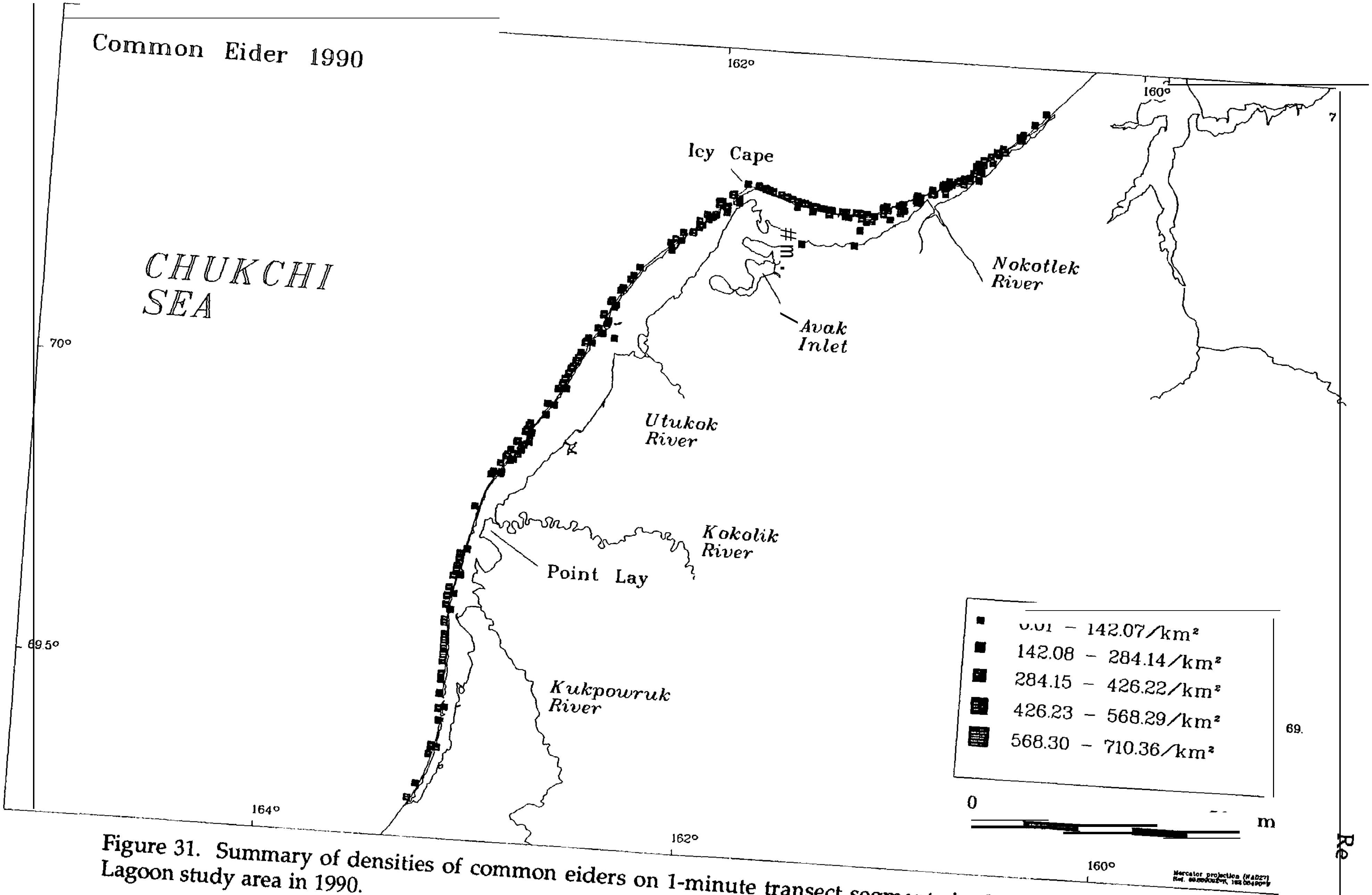


Figure 31. Summary of densities of common eiders on 1-minute transect segments in the Kasegaluk Lagoon study area in 1990.

Table 14. Habitat associations of common eiders during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989		1990	
	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total
Ocean-Nearshore Marine	234	53.5	185	30.4
Ocean Beach	3	0.7	4	0.7
Ocean Surf	5	1.1	2	0.3
Lagoon	194	44.4	415	68.1
Lagoon-Mainland margin*	12	2.7	9	1.5
Mid-Lagoon”	33	7.6	38	6.2
Lagoon-Island margin”	97	22.2	290	47.6
Lagoon Pass”	52	11.9	78	12.8
Shoal/Spit			1	0.2
River Delta	-			
Pond/Lake on Tundra	1	0.2	1	0.2
Tundra	-			
Coastal Marsh				
Mudflat				
River		-		
Stream			1	0.2
All Habitats	437	100.0	609	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

individuals of these two species in 1989 and 1990 were small compared to oldsquaws and common eiders. There were 44 sightings (1.4%) of 2239 mergansers (1. 1%) in 1989 when only five surveys were f lown, and 65 sightings (0.9%) of 4555 mergansers (2.1 %) in 1990 when a full complement of eight surveys was flown (Tables 2-4).

The temporal patterns of abundance of red-breasted mergansers were very different in the two years of surveys. In 1989 the largest number of mergansers was seen during the final survey on 11 September, whereas in 1990 the largest number was seen on 12 August — numbers declined markedly thereafter (Fig. 32).

The spatial distribution of red-breasted mergansers, like that of the oldsquaw and common eider, was closely tied to lagoonside barrier island habitats, especially in the northeastern portion of Kasegaluk Lagoon (Figs. 33 and 34). The portion of transects 1304 around Icy Cape, and the portion of transect 1305 between Akoliakatat Pass and Pingorarok Pass were particularly heavily used by this species. The peak density in 1989 was recorded on 24 August when 300 birds/sq km were recorded east of Akoliakatat Pass (Fig. 33). In 1990 the peak density (422 birds/sq km) was recorded on 22 August at Akoliakatat Pass (Fig. 34). During both years of surveys the highest densities of red-breasted mergansers were regularly recorded in sheltered lagoon waters along the barrier island near Akoliakatat Pass, but in 1990 high densities were also seen at the entrance to Avak Inlet (Append. B-11).

Habitat analyses indicated that in both 1989 and 1990, but notably in 1989, sightings of red-breasted mergansers were mostly in lagoon habitats, primarily the narrow margin of lagoon habitat along the barrier islands (Table 15). Red-breasted mergansers were also one of the species most closely associated with passes in the barrier islands connecting the lagoon with nearshore marine waters of the Chukchi Sea. The proportion of sightings of red-breasted mergansers in lagoon passes was 20.9% in 1989 and 16.9% in 1990 (Table 15).

In contrast to red-breasted mergansers (and most other diving ducks), there were more surf scoters seen in 1989 when only five surveys were flown late in the season (24 August through 11 September 1989), than during 1990 when eight surveys were flown over a much broader period (27 July through 10 September). In total, there were 80 sightings (2.5%) of 1155 surf scoters (0.6%) in 1989 and 56 sightings (0.8%) of 348 surf scoters (0.2%) in 1990 (Tables

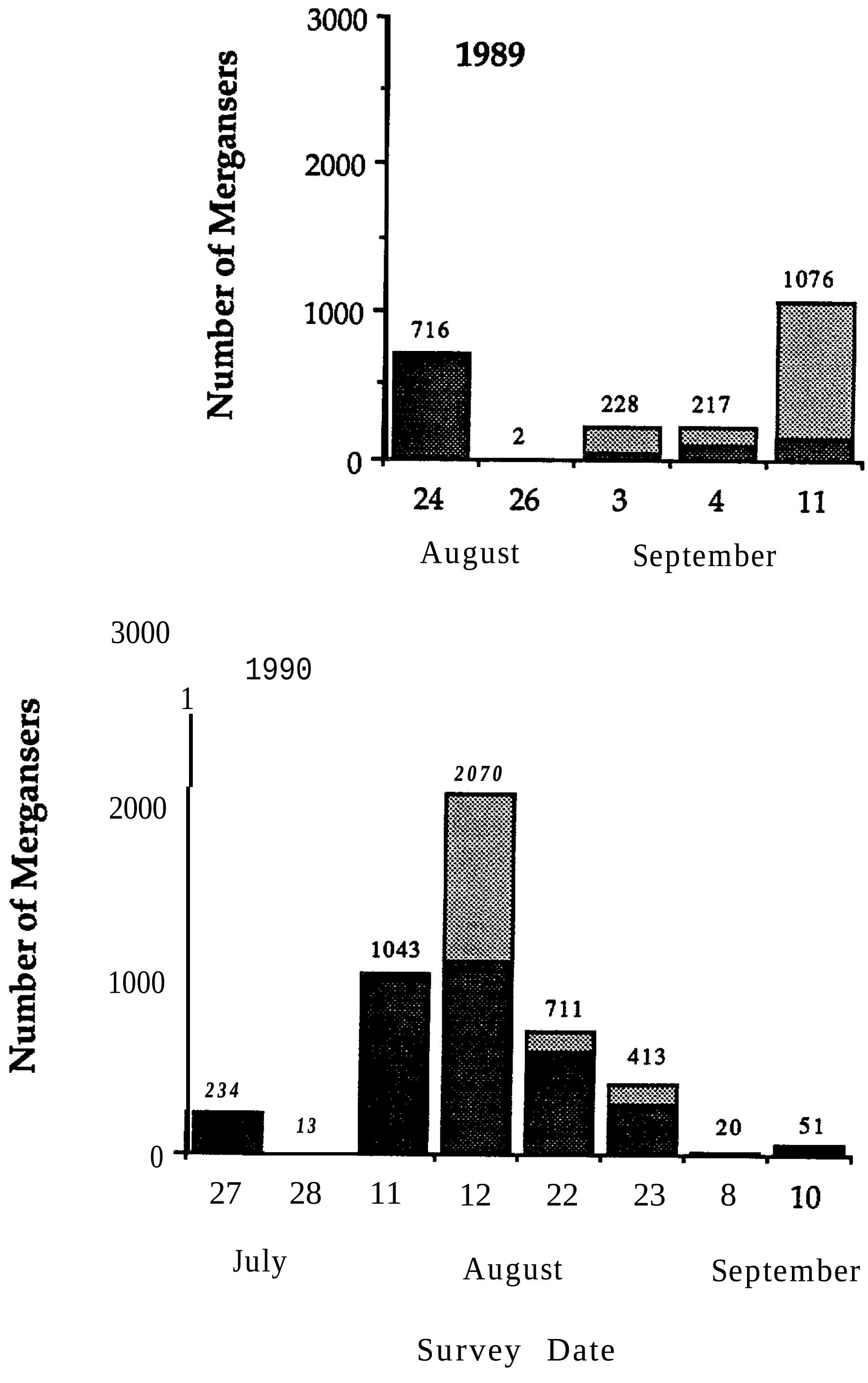


Figure 32. Total number ofred-breasted mergansers seen both on-transect (heavy stippling) and off-transect (light stippling) on-each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska, Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

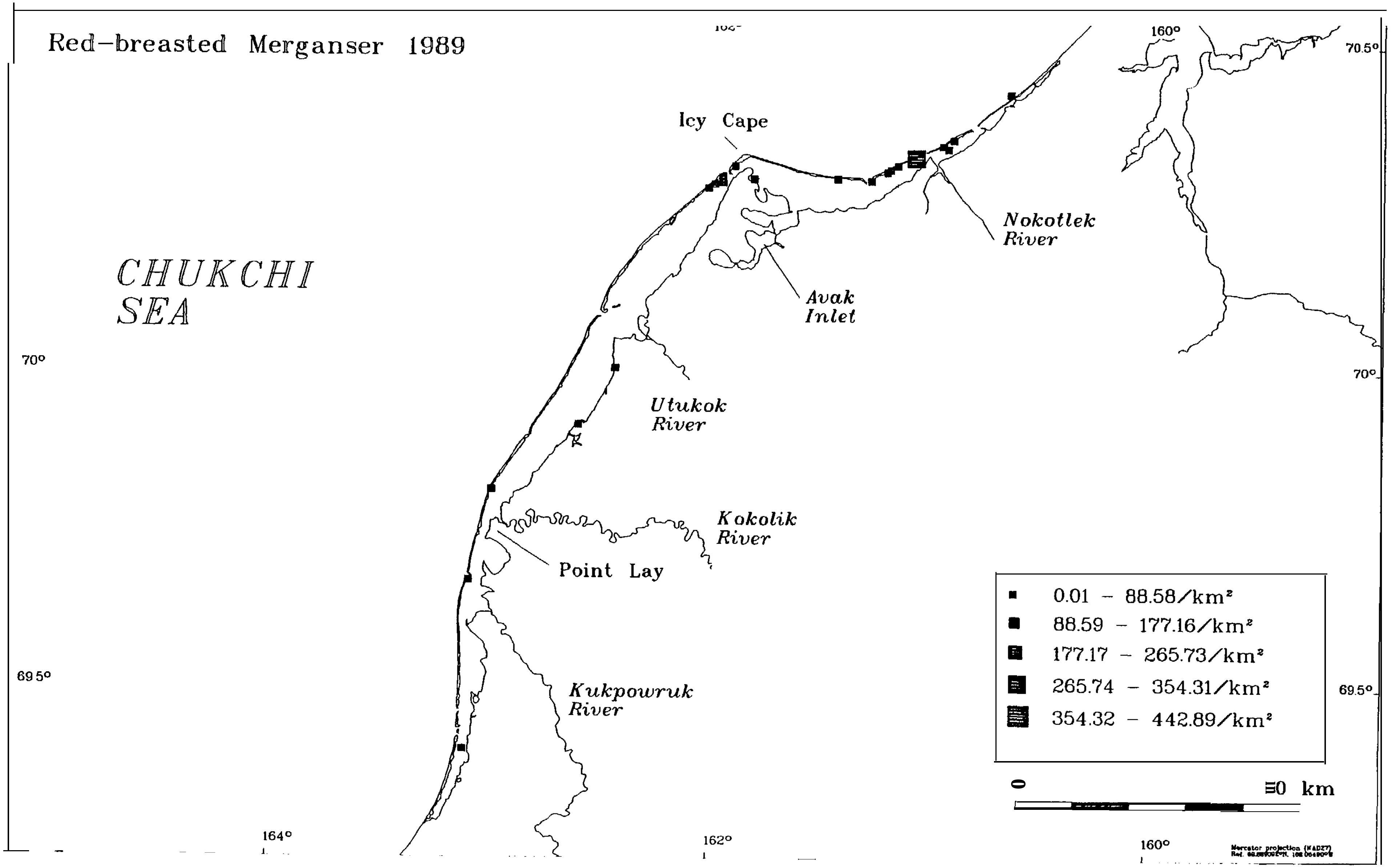


Figure 33. Summary of densities of red-breasted mergansers on 1-minute transect segments in the Kasegaluk Lagoon study area in 1989.

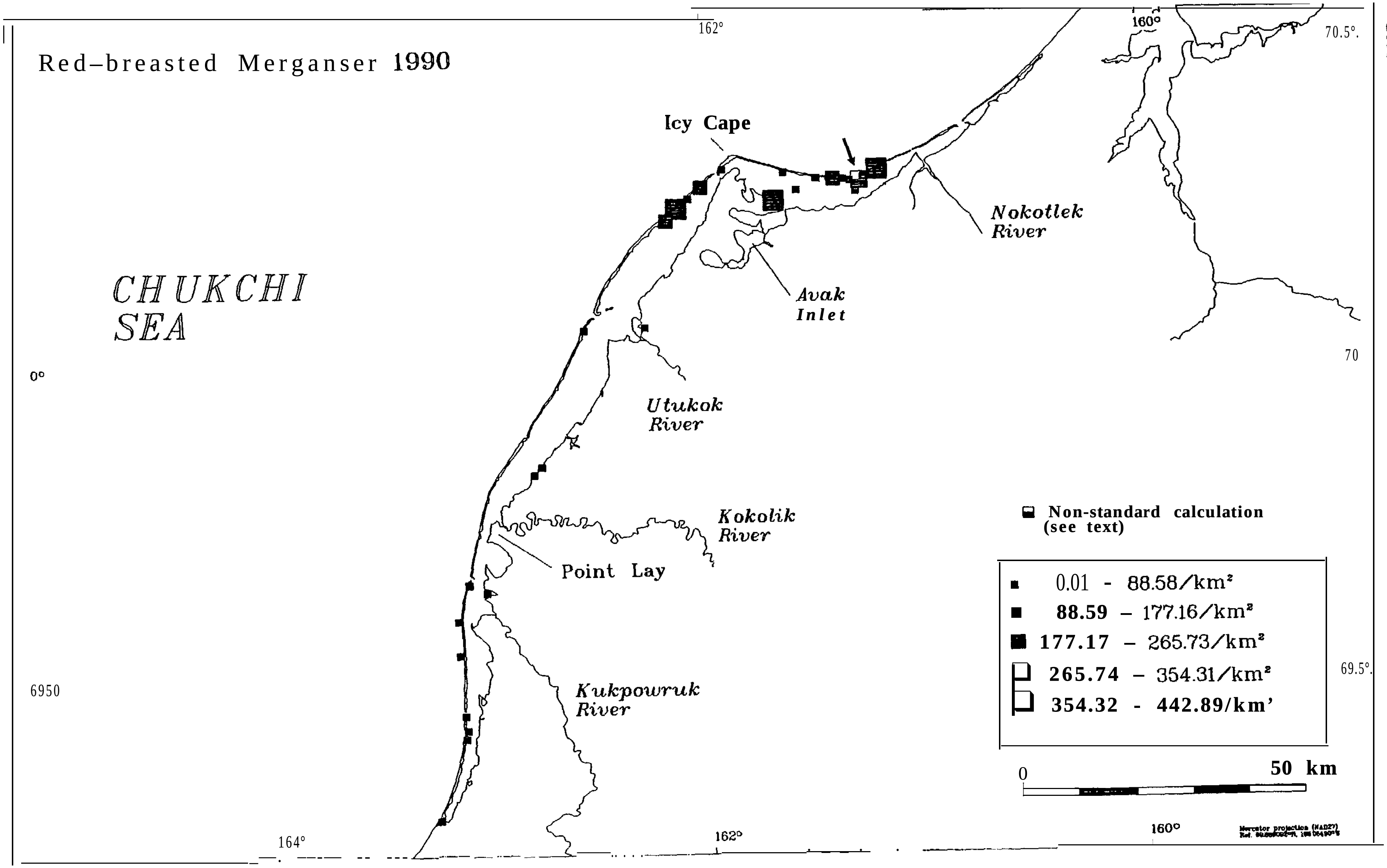


Figure 34. Summary of densities of red-breasted mergansers on l-minute transect segments in the Kasegaluk Lagoon study area in 1990.

Table 15. Habitat associations of red-breasted mergansers during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine	2	4.5		
Ocean Beach			2	3.1
Ocean Surf				
Lagoon	42	95.5	55	84.6
Lagoon-Mainland margin*	6	13.6	6	9.2
Mid-Lagoon*	8	18.2	5	7.7
Lagoon-Island margin*	19	43.1	33	50.8
Lagoon Pass*	9	20.5	11	16.9
Shoal/Spit			1	1.5
River Delta				
Pond/Lake on Tundra			2	3.1
Tundra			1	1.5
Coastal Marsh				
Mudflat			3	4.6
River				
Stream			1	1.5
All Habitats	44	100,0	65	100.0

An asterisk (“) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

2-4). Most birds were recorded during surveys on 4 and 11 September 1989 (Fig. 35).

Thespatial distribution of surf scoters was different from other species of diving ducks seen in this study. They were seen primarily in nearshore marine habitats seaward of the barrier islands (Figs. 36 and 37). The peak density on a l-minute transect segment was as high as 337 birds/sq km on transect 1401 at the far southwestern end of the study area on 11 September 1989; high densities of surf scoters were also seen at this location on other dates in 1989 (Append. B-12).

Habitat analyses indicated that surf scoters were most closely associated with nearshore marine habitats in the study area (Table 16). In 1989 about 71% of all sightings of surf scoters were in nearshore marine habitats, with the remainder of sightings (28.7%) in lagoon-margin habitats. In 1990, the proportion of surf scoter sightings in marine habitats, about 48%, was smaller than the previous year, and, correspondingly, the proportion of sightings in lagoon habitats (46.4%) was greater than in 1989 (Table 16).

Other Waterfowl

The northern pintail (Anas acuta) was the only species of dabbling duck recorded during aerial surveys in the study area in 1989, and aside from a few green-winged teal (Anas crecca), it was also the most common dabbling duck recorded in 1990. Northern pintails were markedly more common in the study area in 1990 (301 or 4.2% of all sightings; 6989 or 3.2% of all individuals) when a full complement of eight aerial surveys was conducted, compared to 1989 (55 sightings or 1.5%; 967 birds or 0.5%) when only five surveys were conducted (Tables 2-4). Pintails appeared to be more abundant in the study area during early-September 1989 compared to the same period in 1990 (Fig. 38).

The spatial distribution of northern pintails was markedly different during the two years of aerial surveys. In 1989 low densities of pintails were recorded at scattered locations along the margins of Kasegaluk Lagoon (Fig. 39), mostly in the SW portion of the study area (i.e., SW of Icy Cape; Append. B-13). Virtually none were recorded in the far NE section of the lagoon. More pintails were seen in the NE section of the lagoon in 1990, but the highest densities were still recorded in the SW section, mainly at the extreme

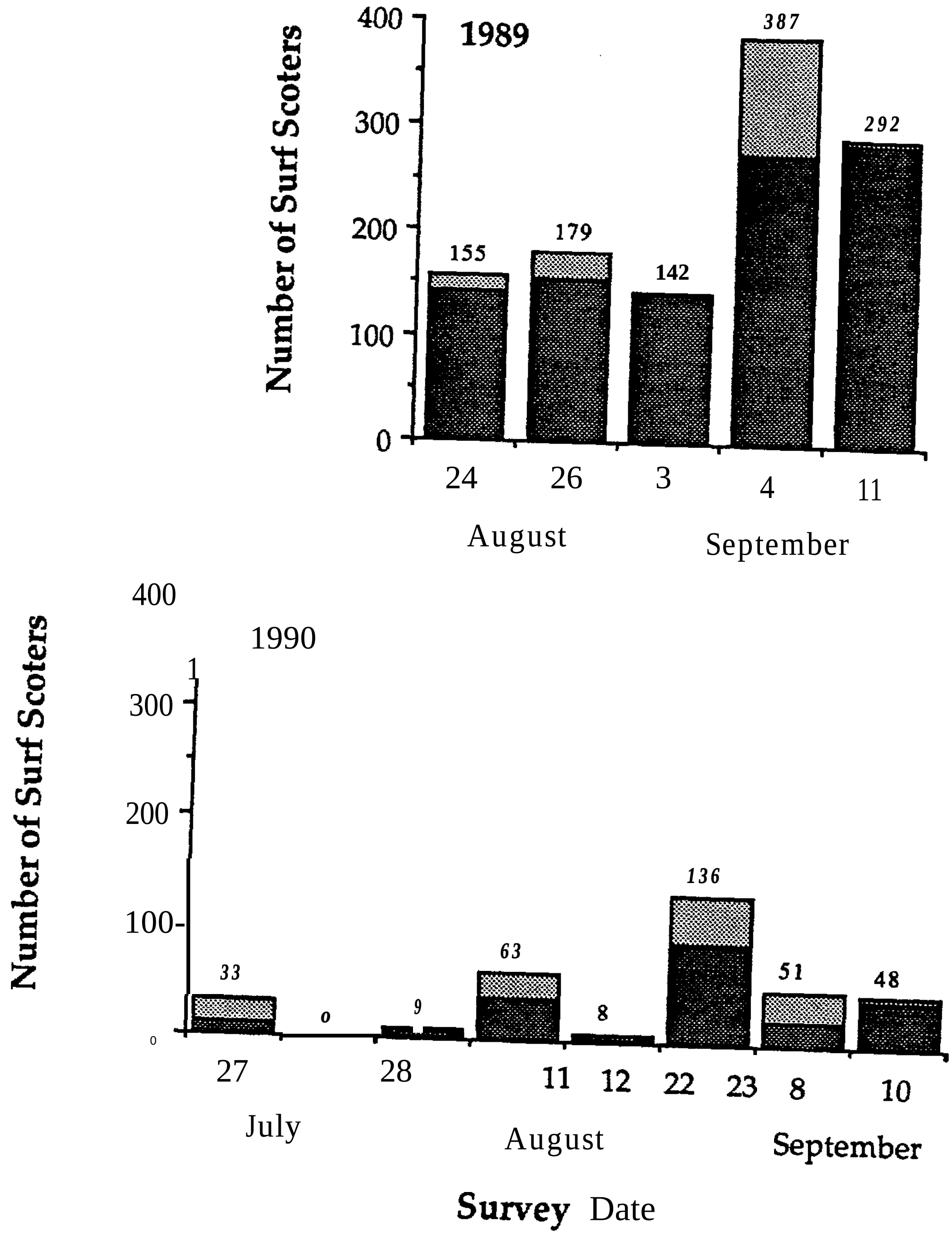


Figure 35. Total number of surf scoters seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 *in* Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

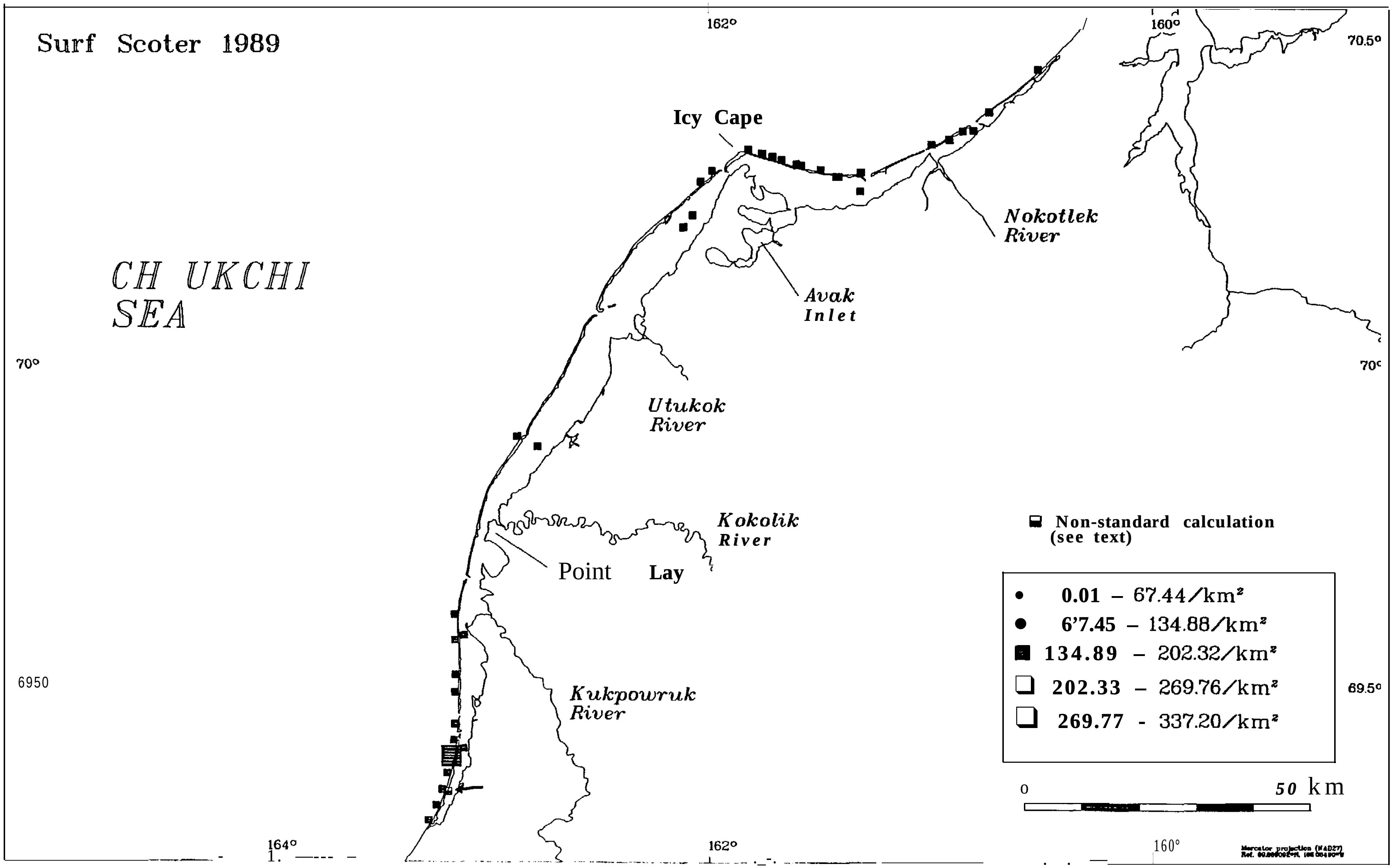


Figure 36. Summary of densities of surf scoters on l-minute transect segments in the Kasegaluk Lagoon study area in 1989.

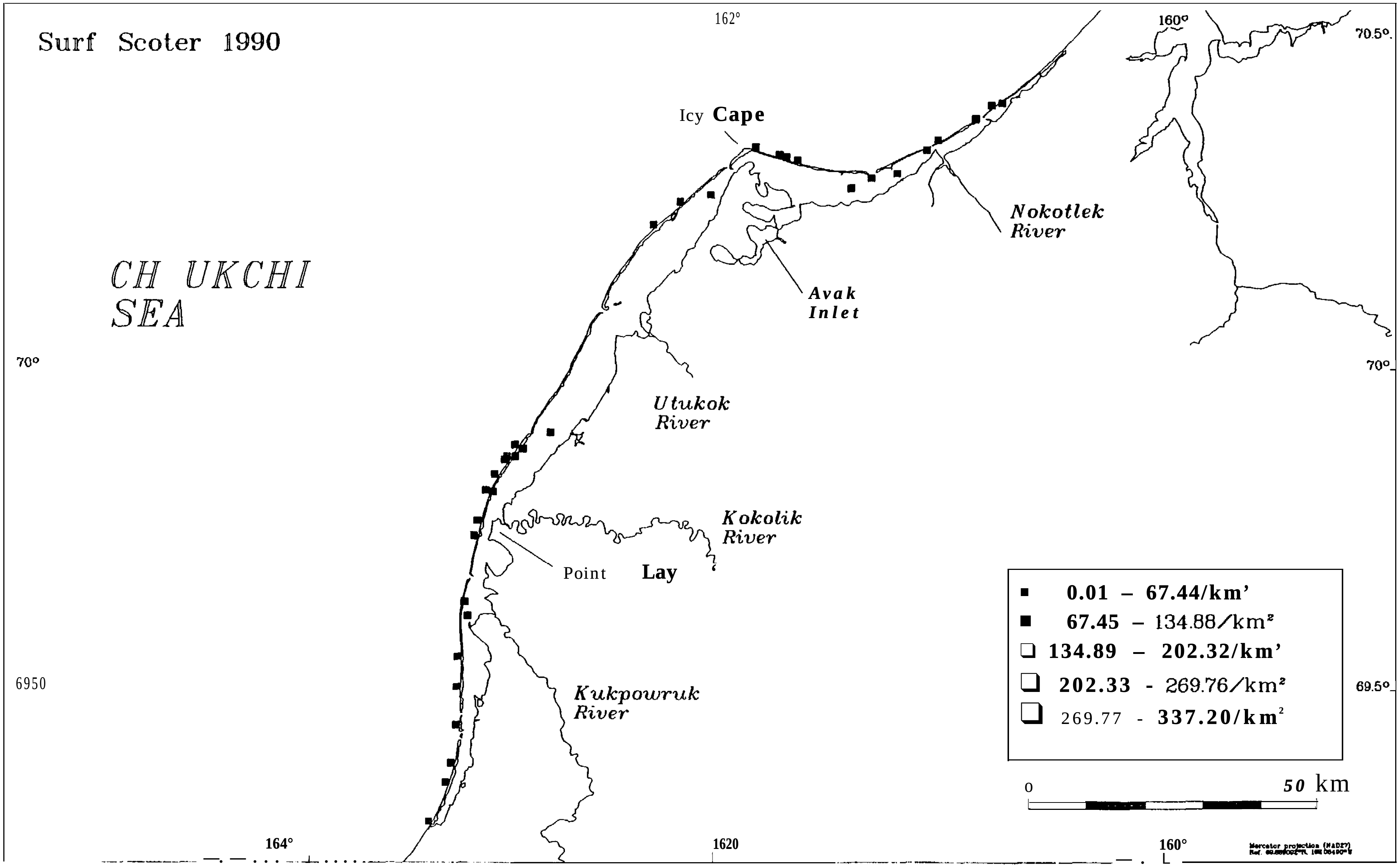


Figure 37. Summary of densities of surf scoters on l-minute transect segments in the **Kasegaluk** Lagoon study area in 1990.

Table 16. Habitat associations of surf scoters during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine	57	71.3	27	48.2
Ocean Beach			3	5.4
Ocean Surf				
Lagoon	23	28.8	26	46.4
Lagoon-Mainland margin”	-		-	
Mid-Lagoon*	9	11.3	7	12.5
Lagoon-Island margin*	14	17.5	19	33.9
Shoal/Spit				
River Delta				
Pond/Lake on Tundra	-			
Tundra				
Coastal Marsh				
Mudflat			-	
River				
Stream				
All Habitats	**80**	100.0	56	100.0

An asterisk (“) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

SW end of the study area (Fig. 40). Thepeak density of northern pintails — 1772 birds/sq km — was recorded on a l-minute transect segment in this area (transect 1106) on 11 August 1990 (Append. B-13).

Habitat analyses indicated that pintails were associated mainly with lagoon habitats in both 1989 and 1990 (45.5% and 45.8%, respectively; Table 17). Habitats along the barrier island-lagoon margin were most heavily used in both years, and in 1989 coastal marsh habitats were also heavily used (30.9% of all sightings). In both years, but mostly in 1990, relatively large proportions of pintail sightings were also recorded in ponds and lakes along the mainland coast (10.9% in 1989 and 21,9% in 1990; Table 17).

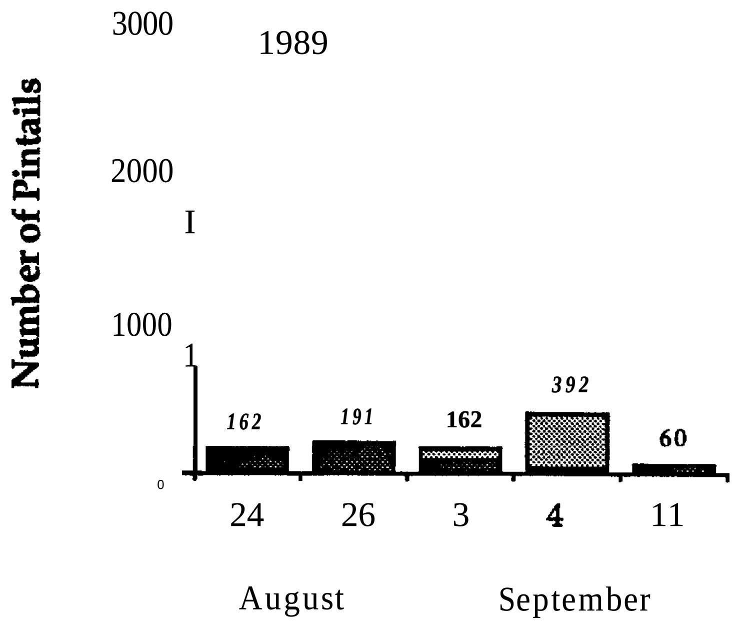
Shorebirds

Shorebirds were the second most abundant group of birds recorded (after waterfowl) during aerial surveys in Kasegaluk Lagoon. Eight species or species groups were recorded during the five surveys in 1989 and 11 speaes or species groups were recorded during the eight surveys in 1990. In 1989 shorebirds constituted 3.7% (121) of all bird sightings and 3.3% (6695) of all individual birds recorded. In 1990 they constituted a much larger proportion of birds recorded — 8.4% (608) of all bird sightings and 17.8% (38,646) of all individuals (Tables 2-4).

Small Shorebirds

The group classified as small shorebirds was particularly abundant in both years (Table 2-4). In 1989 this group represented over three-quarters (77.7%) of all shorebird sightings and 98.5% of all individual shorebirds recorded in the study area. In 1990 they represented nearly two-thirds (63.7%) of all shorebird sightings and over three-quarters (78.870) of all individual shorebirds recorded in the study area (Tables 2 and 3).

The largest proportion of small shorebirds identifiable from the survey aircraft in both 1989 and 1990 was phalaropes (*Phalaropus fulicarius* and *P. lobatus*) (Tables 2 and 3). In 1990 dunlins (*Calidris alpina*) were also recognizable from the survey aircraft, but they constituted a relatively small proportion (only 1.3%) of all shorebird sightings and an even smaller proportion (0.7%) of individual shorebirds (Tables 2 and 3). Although



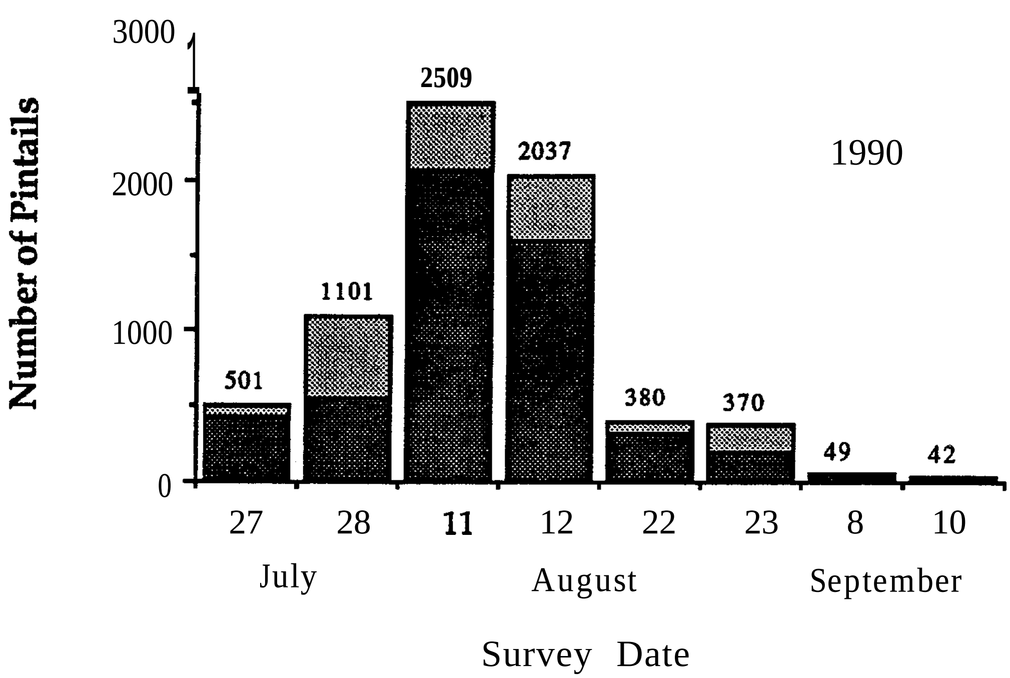


Figure 38. Total number of northern pintails seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

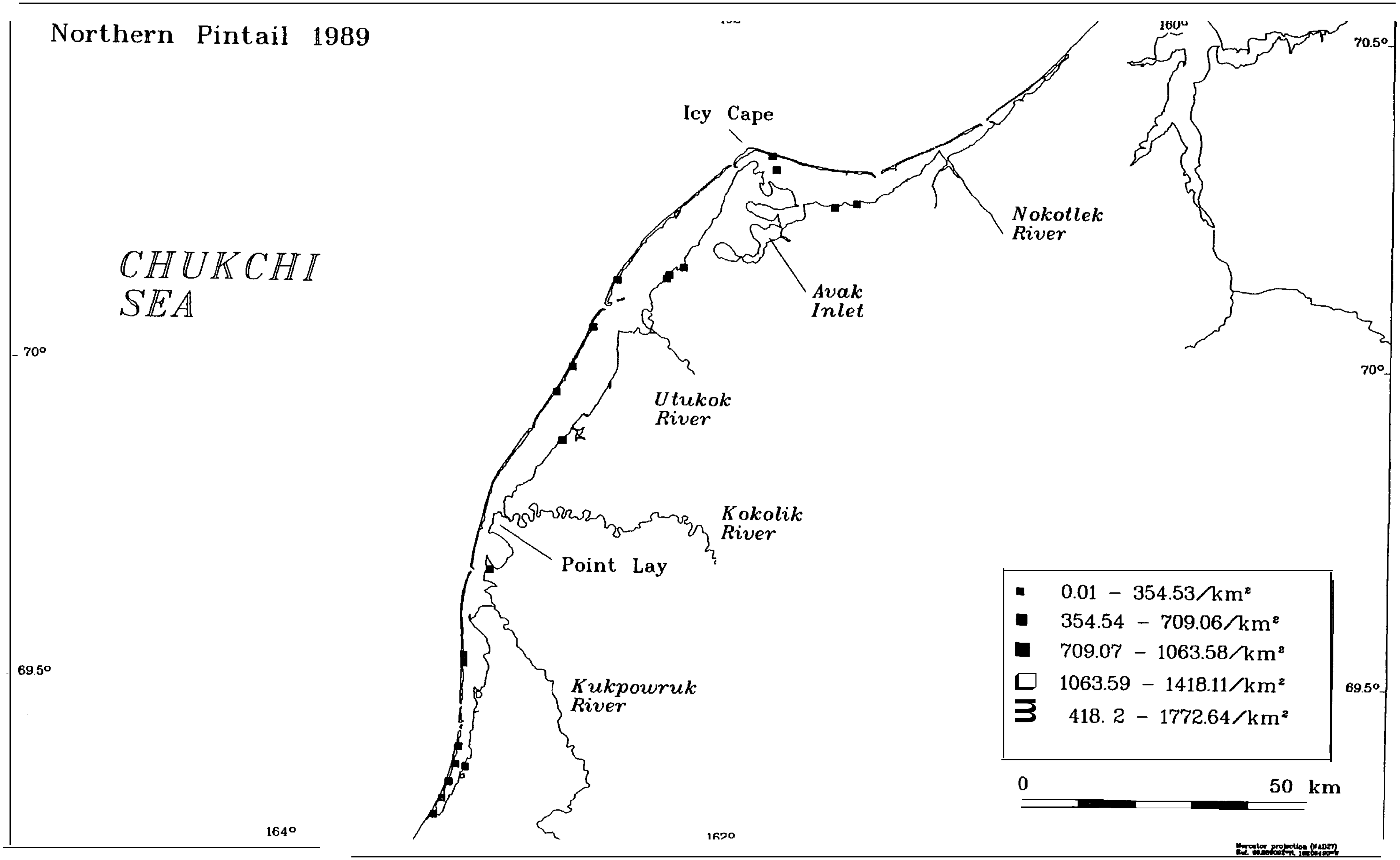


Figure 39. Summary of densities of northern pintails on 1-minute transect segments in the Kasegaluk Lagoon study area in 1989.

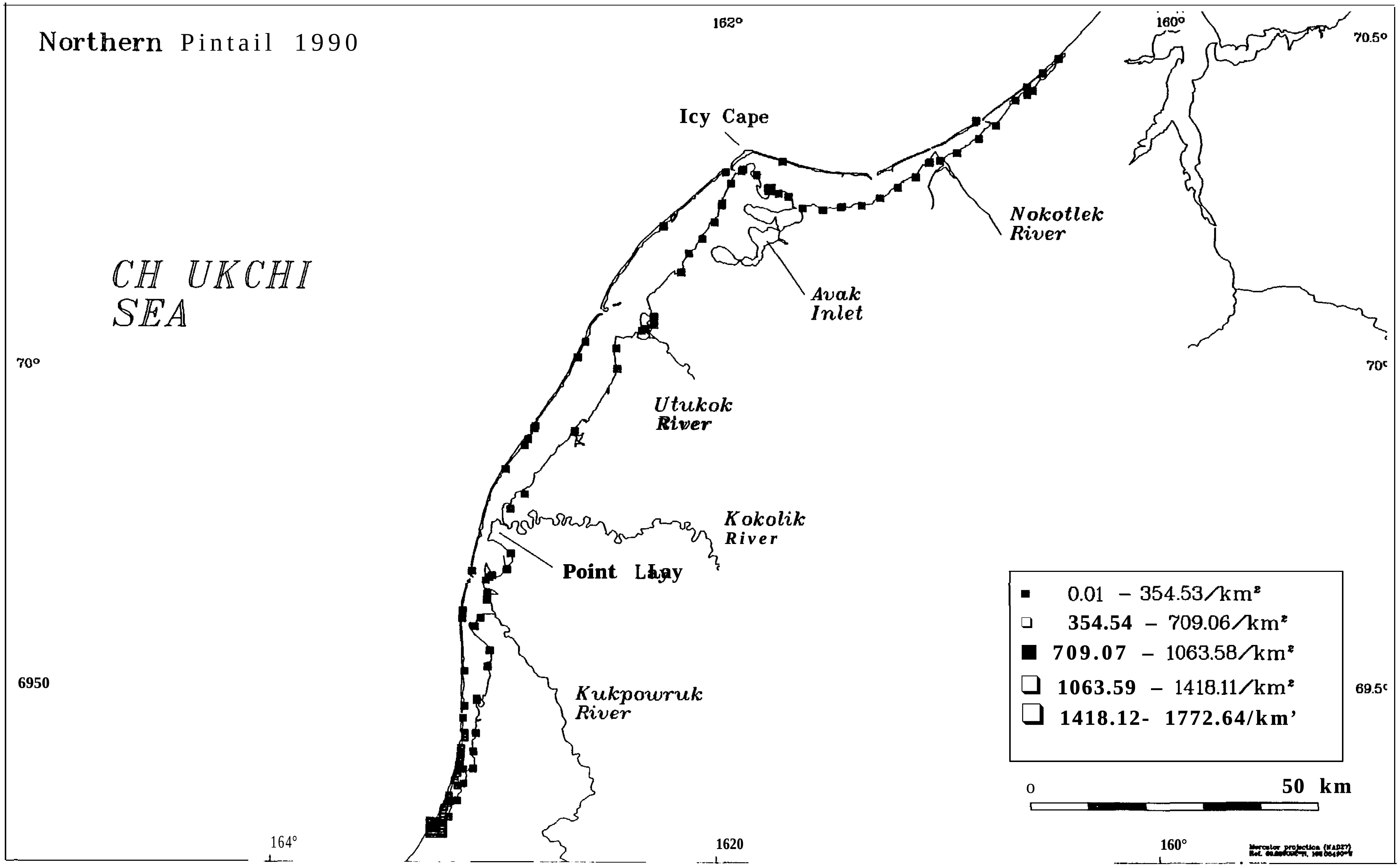


Figure 40. Summary of densities of northern pintails on l-minute transect segments in the **Kasegaluk** Lagoon study area in 1990.

Table 17. Habitat associations of northern pintails during aerial surveys of **Kasegaluk** Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine				
Ocean Beach	1	1.8	7	2.3
Ocean Surf			12	4.0
Lagoon	25	45.5	138	45.8
Lagoon-Mainland margin*	3	5.5	45	15.0
Mid-Lagoon*	1	1.8	15	5.0
Lagoon-Island margin*	21	38.2	78	25.9
Shoal/Spit			1	0.3
River Delta	1	1.8	12	4.0
Pond/Lake on Tundra	6	10.9	66	21.9
Tundra	4	7.3	10	3.3
Coastal Marsh	17	30.9	18	6.0
Mudflat	1	1.8	32	10.6
River			2	0.7
Stream			3	1,0
All Habitats	55	100.0	301	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

western sandpipers (*Calidris mauri*) were not detected from the aircraft during surveys in either year, they were one of the most common small shorebirds seen on the tundra and along the shoreline of Kasegaluk Lagoon at Point Lay during July and early August.

Large shorebirds (plovers and larger) were poorly represented in 1989 (Table 2), but in 1990 they made up 14.6% of all shorebird sightings and 11.4% of all individual shorebirds recorded (Table 3).

The temporal patterns of shorebird abundance were similar in the two years of aerial surveys. In 1989, when only five surveys were conducted late in the season (24 August to 11 September), the peak of shorebird abundance was in late August, when nearly 4000 were recorded. Most shorebirds had departed the study area by early September — only several hundred were recorded during the final survey on 11 September (Fig. 41). In 1990 the peak abundance was also during late August when over 8000 small shorebirds were recorded. In contrast to the pattern in 1989, however, several thousand small shorebirds were still present in the study area during the final aerial survey on 10 September 1990 (Fig. 41).

The spatial distribution of shorebirds was similar during the two years of aerial surveys. Most were recorded in mudflat habitats at the far southwestern end of the study area (Figs. 42 and 43). Peak densities of small shorebirds on l-minute transect segments were in this area on 22 and 23 August 1990 (nearly 2400 birds/sq km; Append. B-14).

Habitat analyses indicated that the largest proportion of small shorebird sightings were in mudflat habitats exposed during low water periods, and in the narrow band of lagoon habitat along the barrier island margin (Table 18). It is notable that in 1990, when sampling was conducted earlier in the season (27 July through 10 September) than in 1989 (24 August through 11 September), a larger proportion of small shorebird sightings were over coastal tundra habitats (21.2% in 1990 vs. 5.3% in 1989). A separate habitat analysis for phalaropes indicated that this species group was most abundant during both years of surveys along the lagoon-barrier island margin (71.4% of all sightings in 1989 and 67.9% in 1990; Table 18).

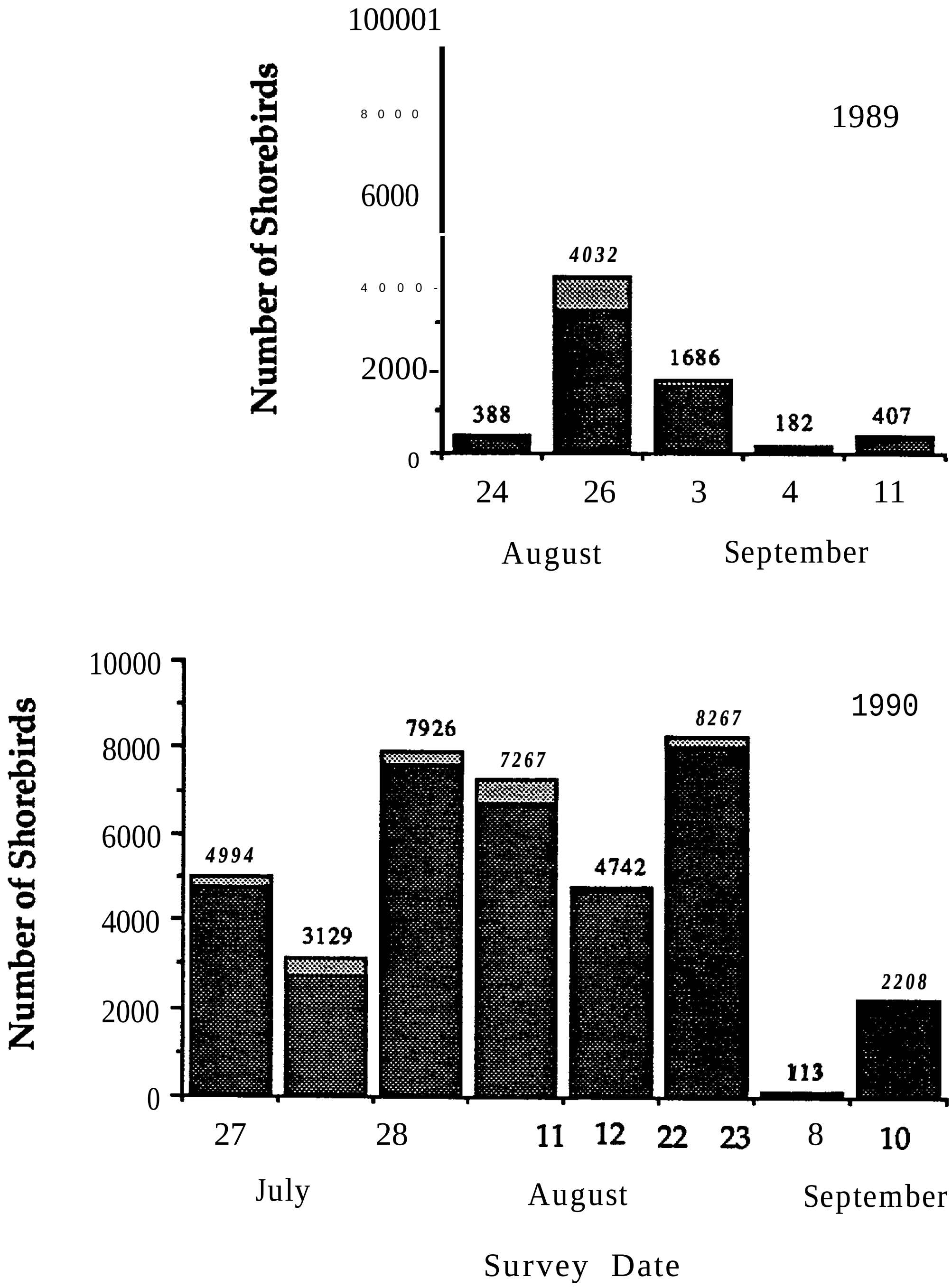


Figure 41. Total number of small shorebirds seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

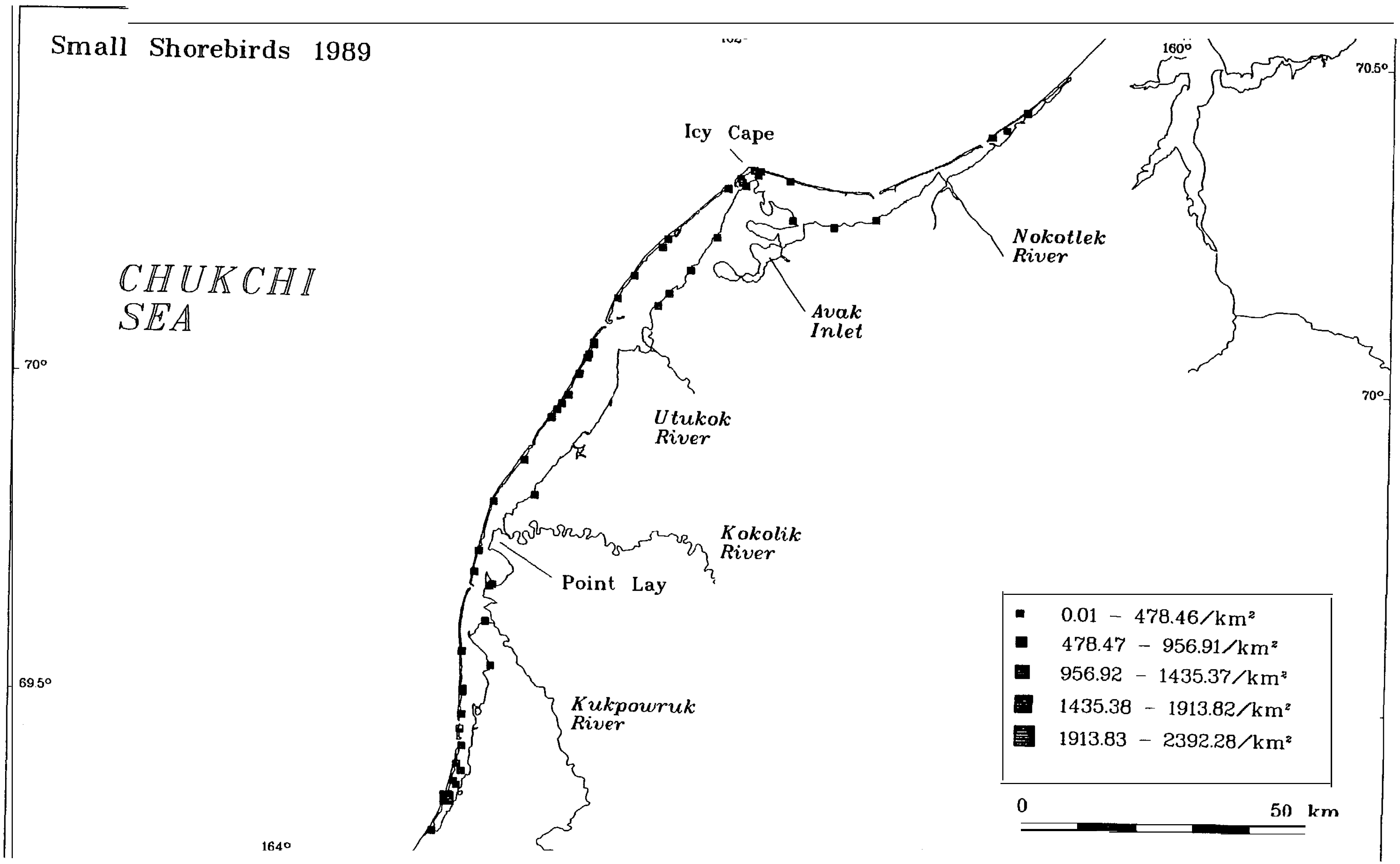


Figure 42. Summary of densities of small shorebirds on 1-minute transect segments in the Kasegaluk Lagoon study area in 1989.

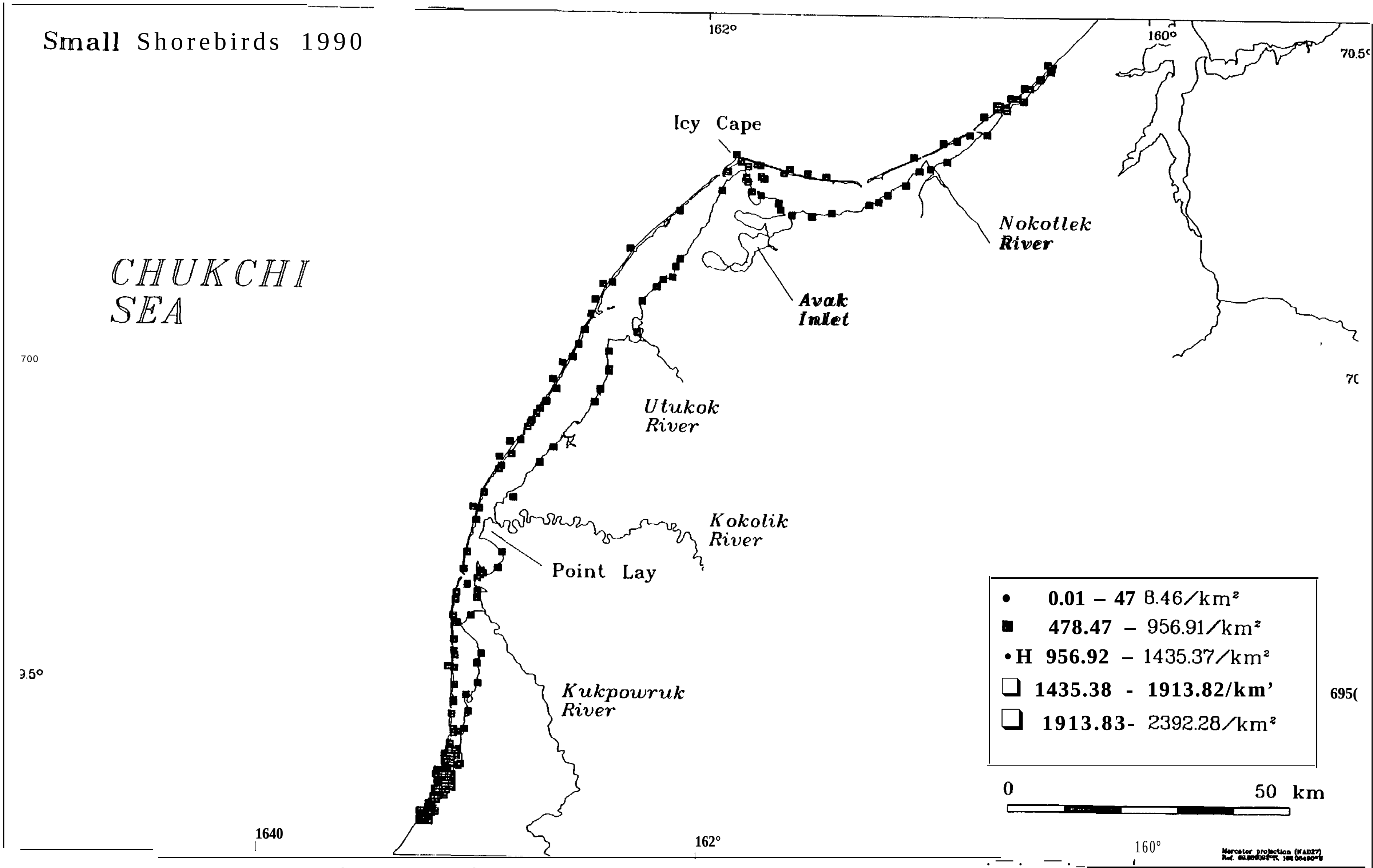


Figure 43. Summary of densities of small shorebirds on l-minute transect segments in the Kasegaluk Lagoon study area in 1990.

Table 18. Habitat associations of small shorebirds during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine				
Ocean Beach			9	2.3
Ocean Surf	-		7	1.8
Lagoon	60	63.8	121	31.3
Lagoon-Mainland margin*	7	7.4	5	1.3
Mid-Lagoon*	7	7.4	14	3.6
Lagoon-Island margin*	46	48.9	102	26.4
Shoal/Spit			1	0.3
River Delta			1	0.3
Pond/Lake on Tundra			13	3.4
Tundra	5	5.3	82	21.2
Coastal Marsh	1	1.1	25	6.5
Mudflat	28	29.8	127	32.8
River			-	
Stream	-		1	0.3
All Habitats	94	100.0	387	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

Raptors

Raptors were relatively rare in the Kasegaluk lagoon area, making up only 2.1 % (68) of all bird sightings in 1989 and 1.3% (96) of all sightings in 1990. Five species of raptors were recorded in 1989 and seven species were recorded in 1990 (Tables 2-4). They made up less than 1.0% of the total number of individual birds seen in both 1989 and 1990. Although some raptors were seen on each aerial survey in both 1989 and 1990, more were seen in 1990 when a full complement of surveys was conducted.

Snowy Owl (Nyctea scandiaca)

Nearly all raptor sightings in both years were of snowy owls. In 1989 snowy owls made up 91 '%0 of both all sightings and all individual raptors recorded in the study area. In 1990 snowy owls made up 81% of both all raptor sightings and all individual raptors recorded in the study area (Tables 2-4). There was no clear peak of snowy owl abundance in 1989, but the greatest numbers were seen in late August`through mid-September; the peak in 1990 was in late July through mid-August (Fig. 44).

In both years of surveys virtually all snowy owls were seen along the mainland shoreline transects. More were seen at the far southwestern end of the study area in 1989 than in 1990 (Figs. 45 and 46). Peak linear densities of snowy owls on 1-minute transect segments were low compared to most other species or species groups; the maximum value was only 1.01 birds/linear km. This density was recorded along the mainland shoreline south of the Kukpowruk River delta on 11 September 1989, and in the Icy Cape area on 28 July 1990 (Append. B-15).

Habitat analyses indicated that by far the largest proportion of snowy owl sightings were in coastal tundra habitats (8.06% in 1989 and 87.2% in 1990; Table 19). In both years, however, a notable proportion of snowy owl sightings were also recorded along ocean beaches and along the lagoon-mainland margin (Table 19).

Aside from a single sighting of a bald eagle (**Haliaeetus leucocephalus**), few individuals of other species of raptors were seen in the study area in 1989 (Table 2). In 1990, on the other hand, there were five sightings of single golden eagles (**Aquila chrysaetos**), four sightings of single gyrfalcons (**Falco**

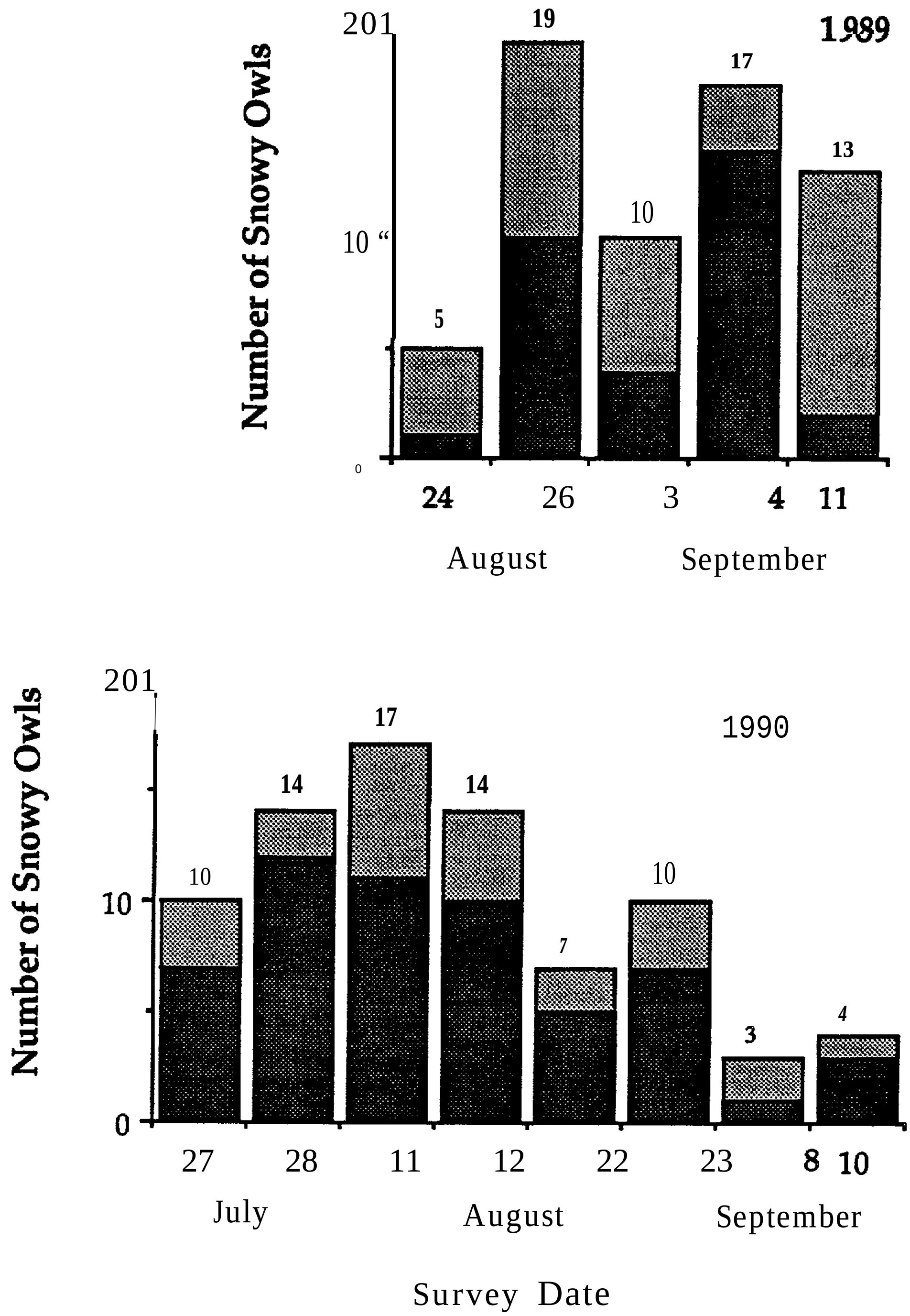


Figure 44. Total number of snowy owls seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see ‘METHODS’ section).

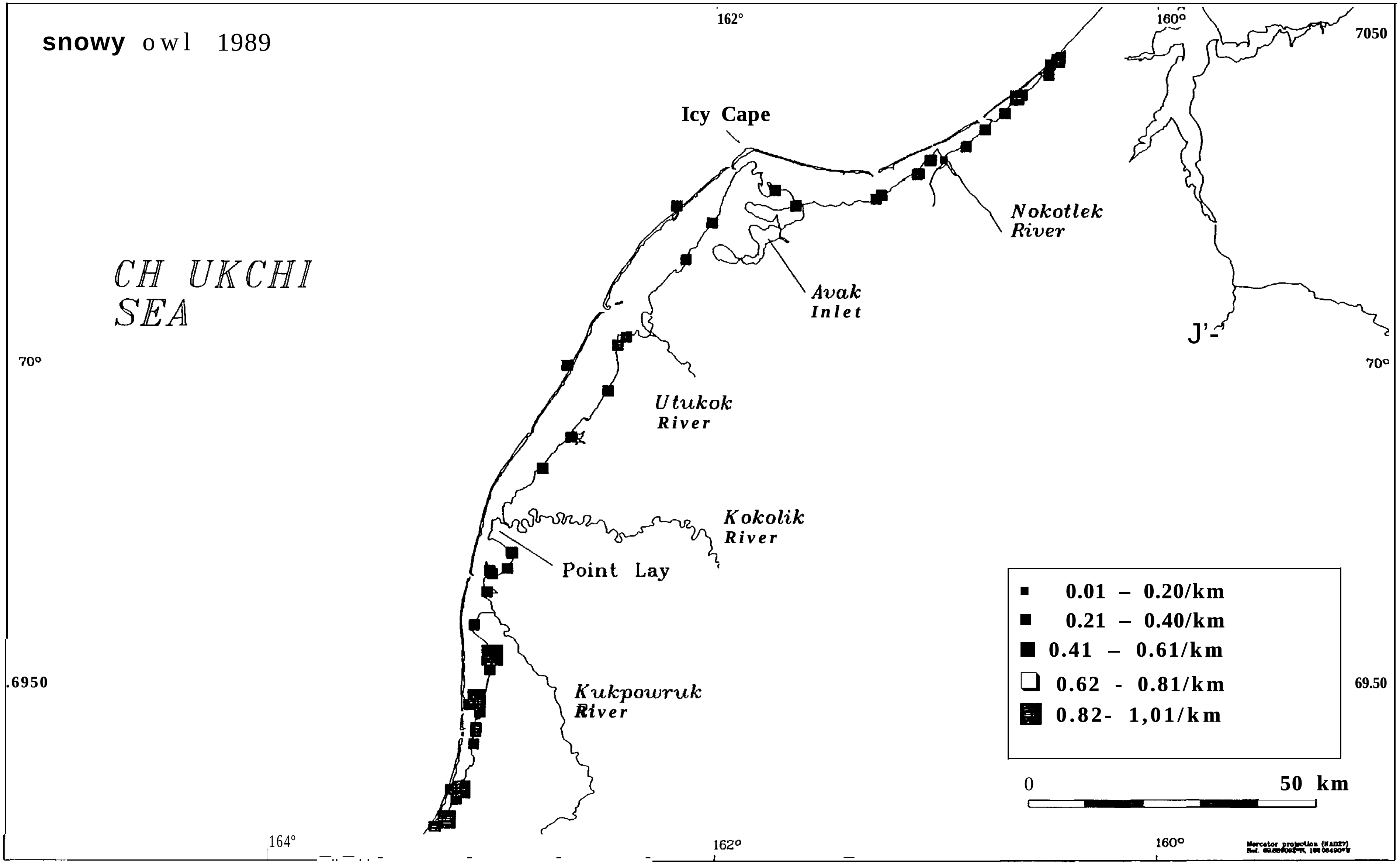


Figure 45. Summary of densities of snowy owls on l-minute transect segments in the **Kasegaluk** Lagoon study area in 1989.

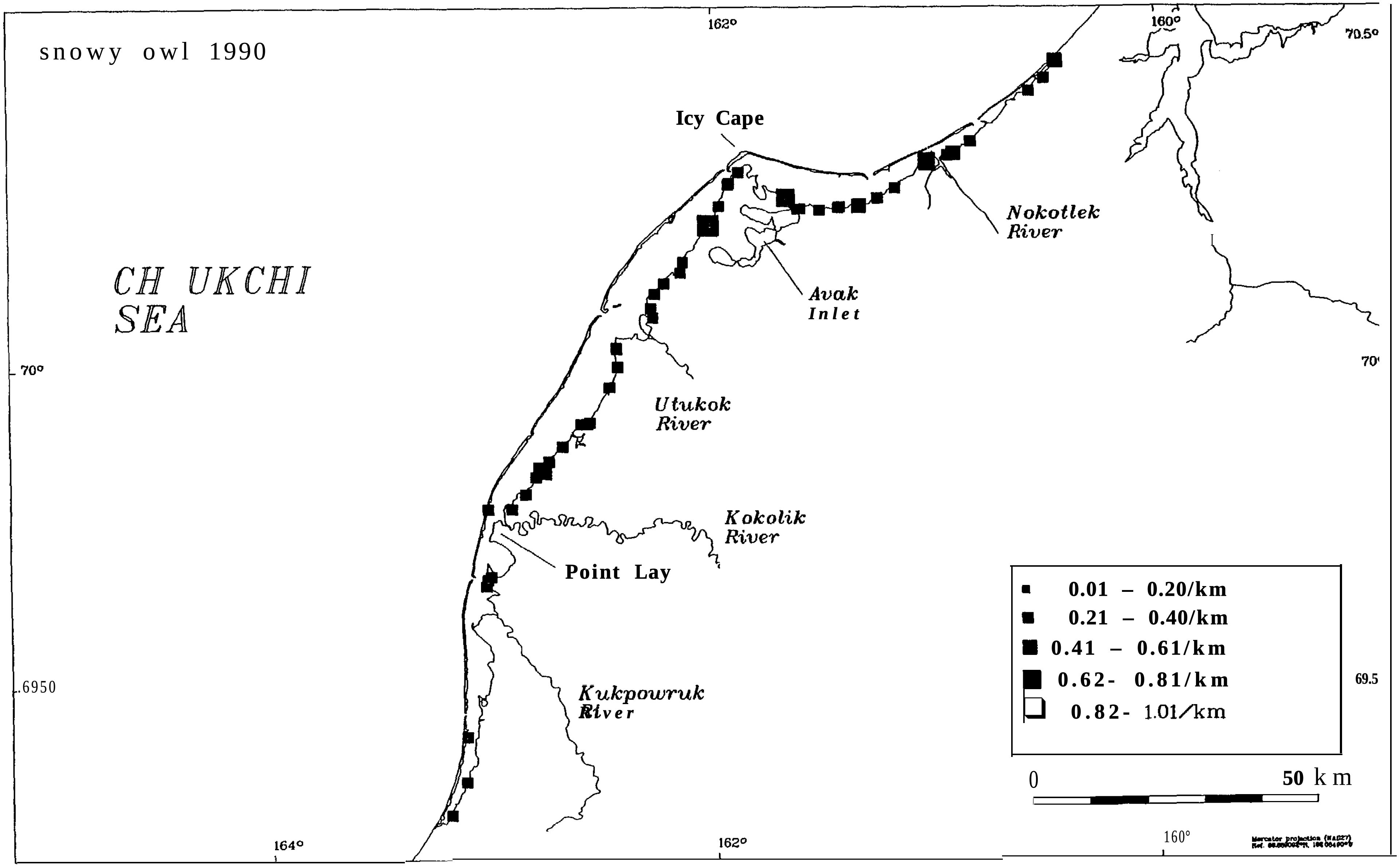


Figure 46. Summary of densities of snowy owls on l-minute transect segments in the **Kasegaluk** Lagoon study area in 1990.

Table 19. Habitat associations of snowy owls during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989		1990	
	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total
Ocean-Nearshore Marine				
Ocean Beach	4	6.5	3	3.8
Ocean Surf				
Lagoon	8	12.9	3	3.8
Lagoon-Mainland margin*	7	11.3	1	1.3
Mid-Lagoon*				
Lagoon-Island margin*	1	1.6	2	2.6
Shoal/Spit				
River Delta			1	1.3
Pond/Lake on Tundra			1	1.3
Tundra	50	80.6	68	87.2
Coastal Marsh			1	1.3
Mudflat			1	1.3
River				
Stream				
All Habitats	62	100.0	78	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category "Lagoon".

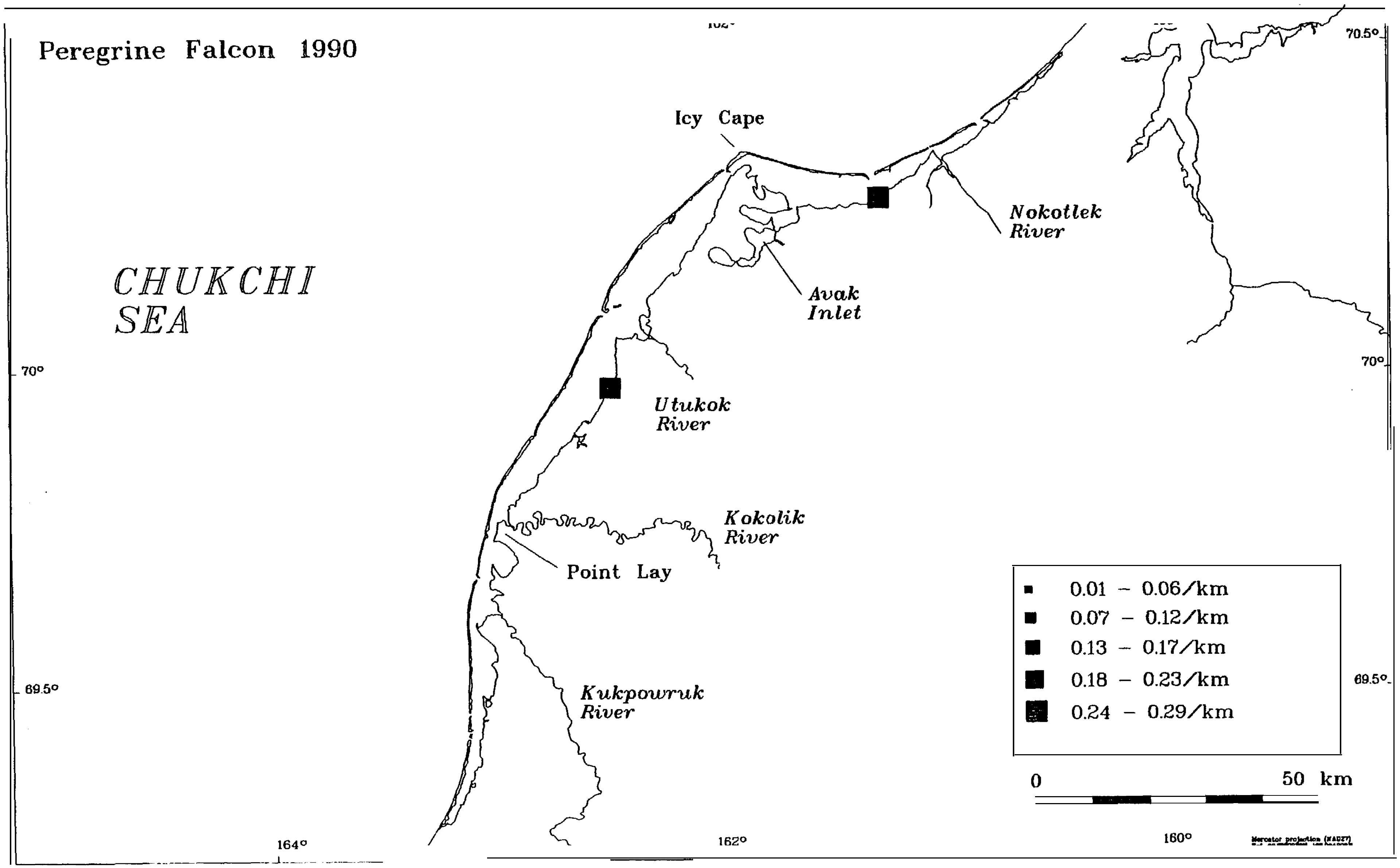


Figure 47. Summary of densities of peregrine falcons on 1-minute transect segments in the Kasegaluk Lagoon study area in 1990.

rusticolus), and three sightings each of single northern harriers (Circus cyaneus) and single peregrine falcons (Falco peregrinus) (Tables 3 and 4; Fig. 47).

Passerine

Passerine (perching) birds made up less than 1% of all bird sightings in both 1989 and 1990 (Tables 2-4). There were five species or species groups recorded in 1989 and four recorded in 1990. In 1989 most passerine were seen during the last survey on 11 September, whereas in 1990 most passerine were seen on 23 August (Fig. 48).

Snow buntings (Plectrophenax nivalis) were the most abundant passerine, accounting for 65% (31 of 48) and 56% (120 of 215) of all individuals seen in 1989 and 1990, respectively.

With the exception of one sighting of six common ravens (Corvus corax) feeding on a whale carcass on a barrier island, all passerine were sighted in tundra habitats on mainland shoreline transects. The highest density of passerine on a l-minute transect segment was 18.16 birds/linear km along the mainland transect near Icy Cape (Figs. 49 and 50).

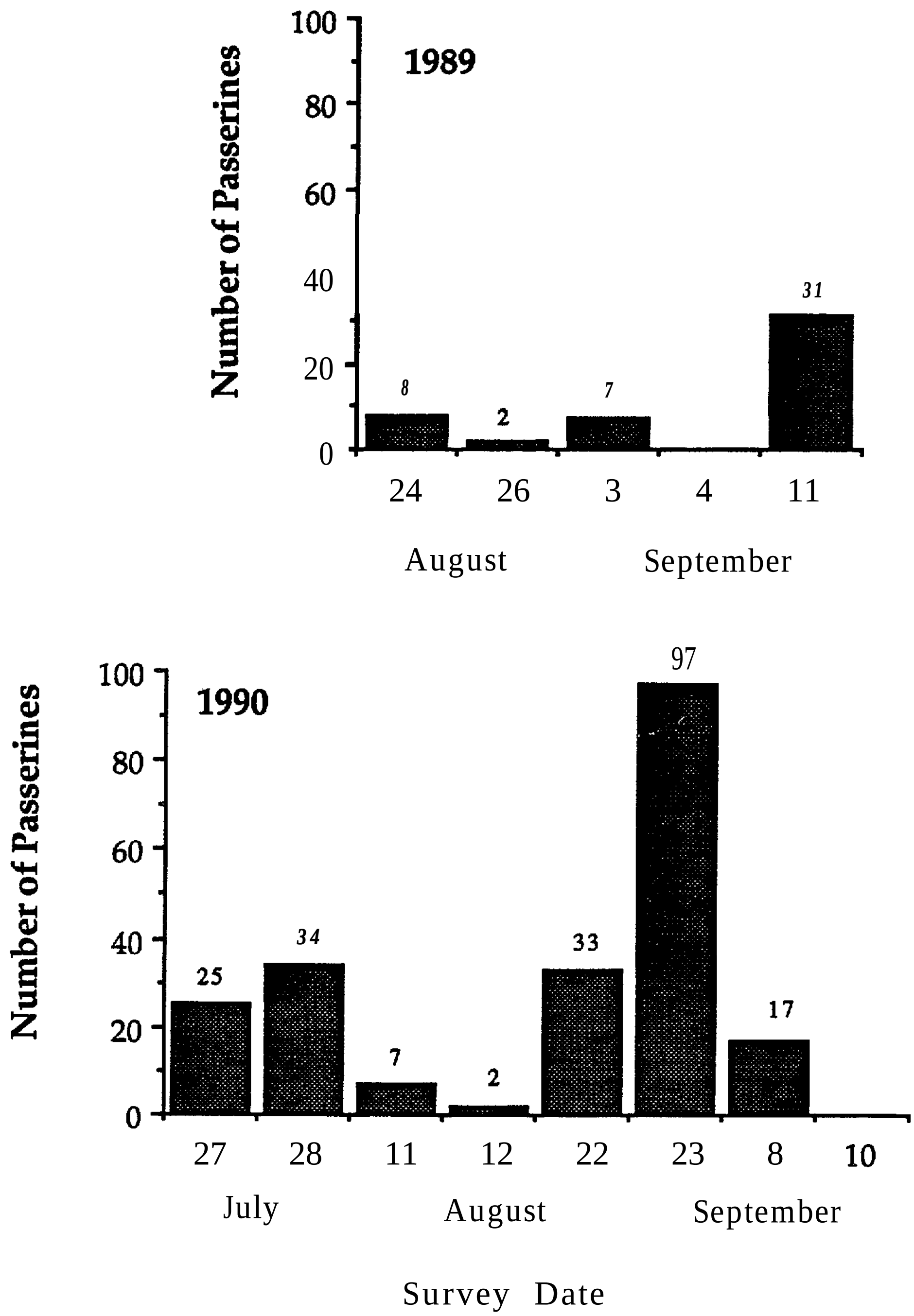


Figure 48. Total number of passerine seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

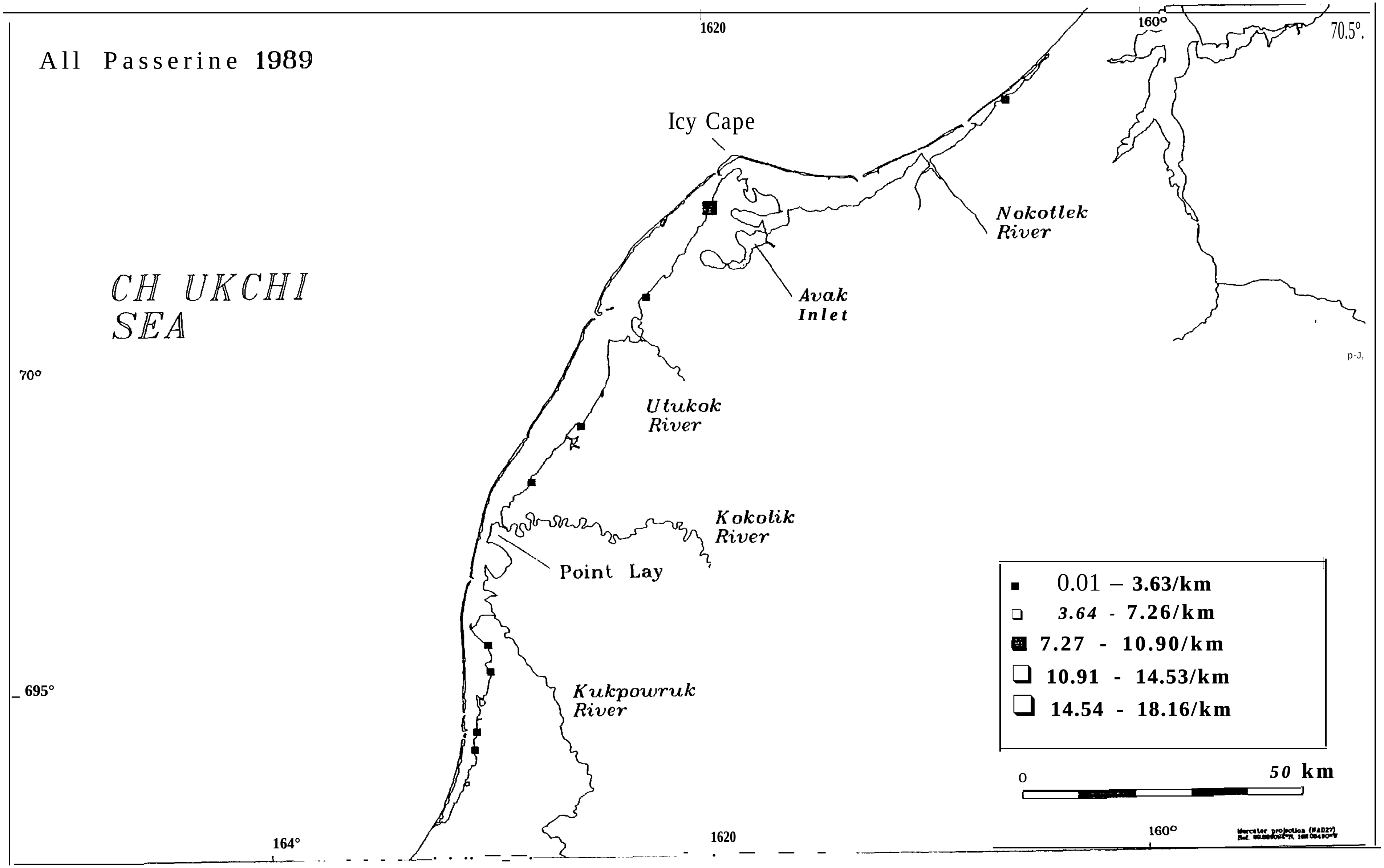


Figure 49. Summary of densities of passerine on l-minute transect segments in the Kasegaluk Lagoon study area in 1989.

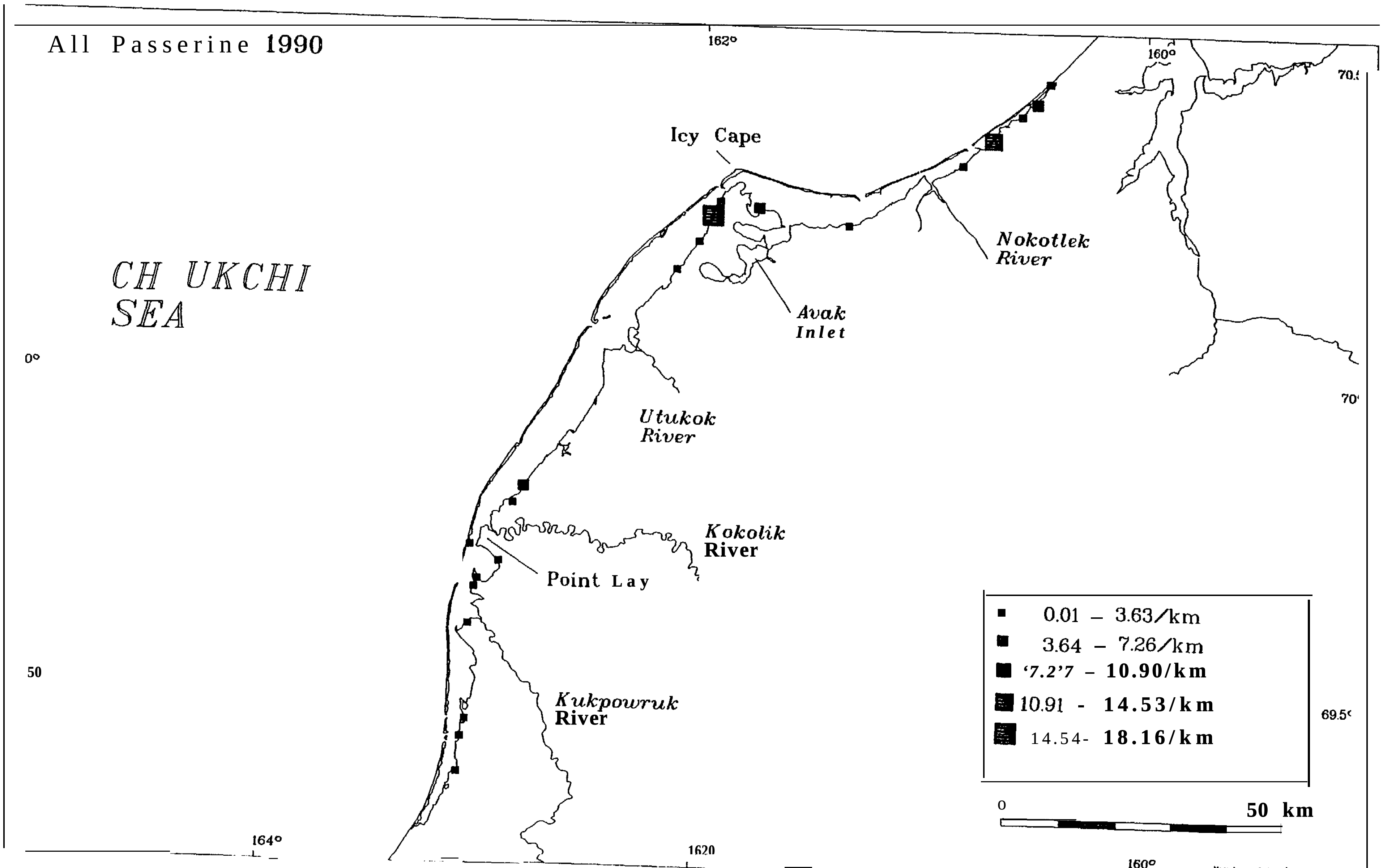


Figure 50. Summary of densities of passerine on l-minute transect segments in the Kasegaluk Lagoon study area in 1990.

Terrestrial Mammals

Terrestrial mammals were observed on every aerial survey conducted in the Kasegaluk Lagoon study area in both 1989 and 1990. In both years three species of terrestrial mammals were recorded (Tables 20 and 21), but far fewer sightings and individuals were seen in 1989 compared to 1990.

Barren-ground Caribou (Rangifer tarandus)

In both years barren-ground caribou were the most abundant terrestrial mammal recorded. This one species represented 88.0% of all sightings and 97.0% of all individual terrestrial mammals recorded in 1989, and 96.1% of all sightings and 99.1% of all individual terrestrial mammals recorded in 1990.

The temporal patterns of terrestrial mammal abundance in 1989 and 1990 were greatly influenced by the movements of caribou through the study area. In 1989 the peak of caribou abundance was during the last survey, i.e., on 11 September (Fig. 51). In 1990, on the other hand, the peak of abundance was in late August (Fig. 51).

The spatial patterns of caribou abundance in the study area were similar during the two years of surveys (Figs. 52 and 53). The highest densities on l-minute transect segments were recorded in tundra habitats along the mainland shoreline, primarily in the far northeastern and southwestern parts of the study area. The peak density in the NE was 20.45 caribou/sq km along transect 1102 on 11 September (Append. B-16). In 1990 the peak density of caribou in this same area was 48.2/sq km on 23 August. But the highest density of caribou during the two years of surveys, 60.30 individuals / sq km, was recorded farther south, along transects 1105 and 1106 on 22 August 1990 (Append. B-16).

Habitat analyses indicated that in 1989, when only five surveys were flown late in the season (24 August through 11 September), all caribou were seen in coastal tundra habitats. In 1990, on the other hand, when more surveys were flown earlier in the season (27 July through 10 September), a larger proportion of caribou sightings were along the beaches and lagoon-margins of the study area (Table 22).

Table 20. Total number of mammal and other sightings and individuals seen both on- and off-transect during 5 aerial surveys in Kasegaluk Lagoon, Chukchi Sea, Alaska, 24 August to 11 September 1989.

Species	No. Sightings	% of All Mammal Sightings	No. Indiv.	% of All Indiv. Mammals
Barren-ground Caribou	103	36.9	555	10.9
Grizzly Bear	3	1.1	3	0.1
Grizzly Bear Tracks	10	3.6	13	0.3
Arctic Fox	1	0.4	1	0.0
All Terrestrial Mammals	117	41.9	572	11.3
Pacific Walrus	16	5.7	17	0.3
Spotted Seal	125	44.8	4,460	88.0
Ringed Seal	1	0.4	1	0.0
Unid. Marine Mammal	20	7.2	20	0.4
All Marine Mammals	162	58.1	4,498	88.7

Other Groups	No. Sightings	% of All Incidental Sightings	No. Indiv.	% of All Incidental Groups
Boat	1	100.0	1	100.0

Table 21. Total number of mammal and other sightings and individuals seen both on-and off-transect during 8 aerial surveys in Kasegaluk Lagoon, Chukchi Sea, Alaska, 27 July to 10 September 1990.

Species	No. Sightings	% of All Mammal Sightings	No. Indiv.	% of All Indiv. Mammals
Barren-ground Caribou	470	53.5	2,276	15.9
Musk Ox	2	0.2	2	0.0
Grizzly Bear	11	1.3	12	0.1
Grizzly Bear Tracks	6	0.7	6	0.0
All Terrestrial Mammals	489	55.6	2,296	16.0
Pacific Walrus	3	0.3	3	0.0
Spotted Seal	381	43.3	12,023	83.9
Ringed Seal	1	0.1	1	0.0
Bearded Seal	1	0.1	1	0.0
Unid. Seal	1	0.1	1	0.0
Unid. Marine Mammal	3	0.3	3	0.0
All - Mammals	390	44.4	12,032	84.0

Other Groups	No. Sightings	% of All Incidental Sightings	No. Indiv.	% of All Incidental Groups
Boat	11	73.3	12	60.0
Survey Ship	1	6.7	1	5.0
Helicopter	1	6.7	1	5.0
Human	2	13.3	6	30.0

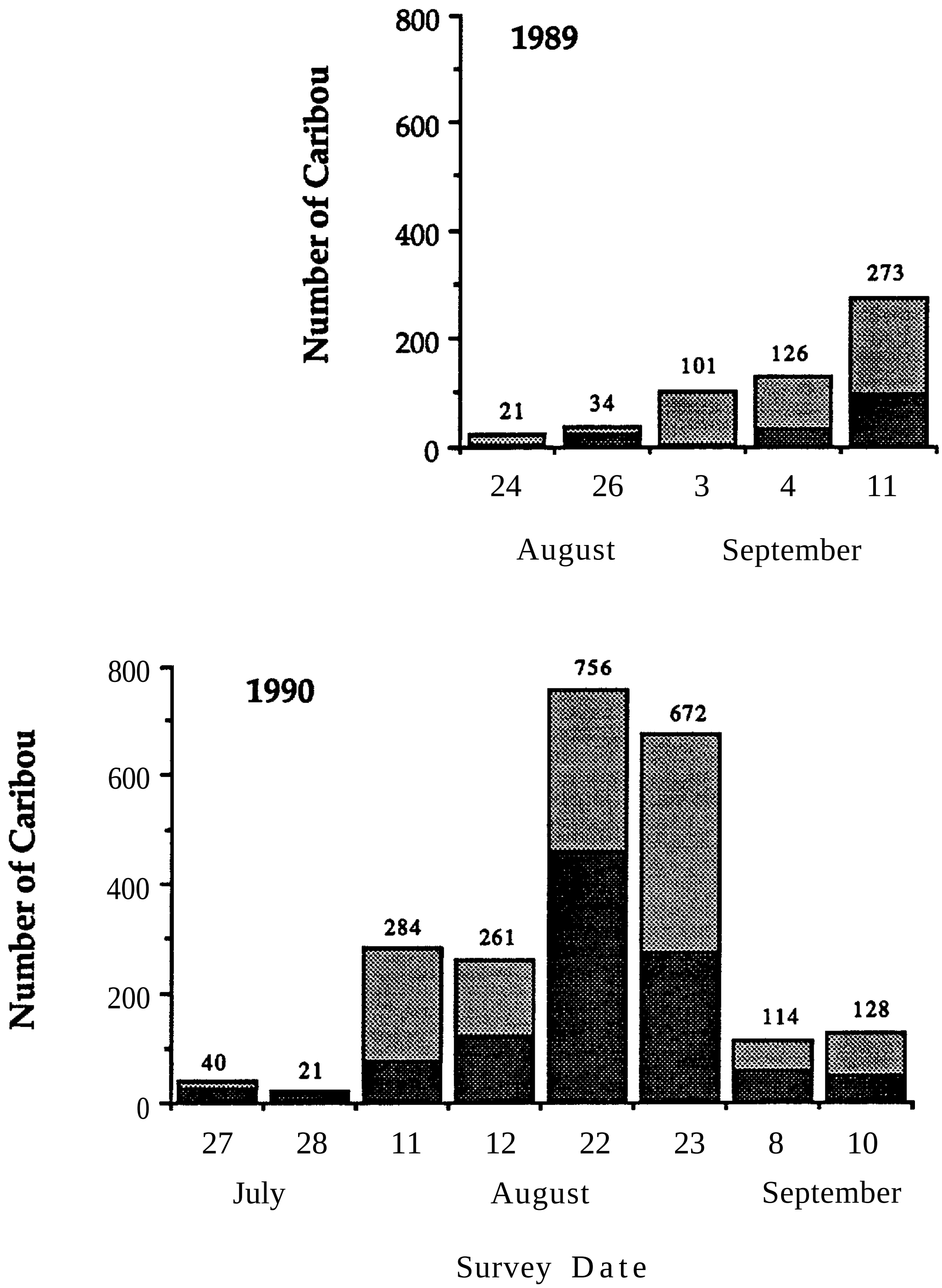


Figure 51. Total number of barren-ground caribou seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

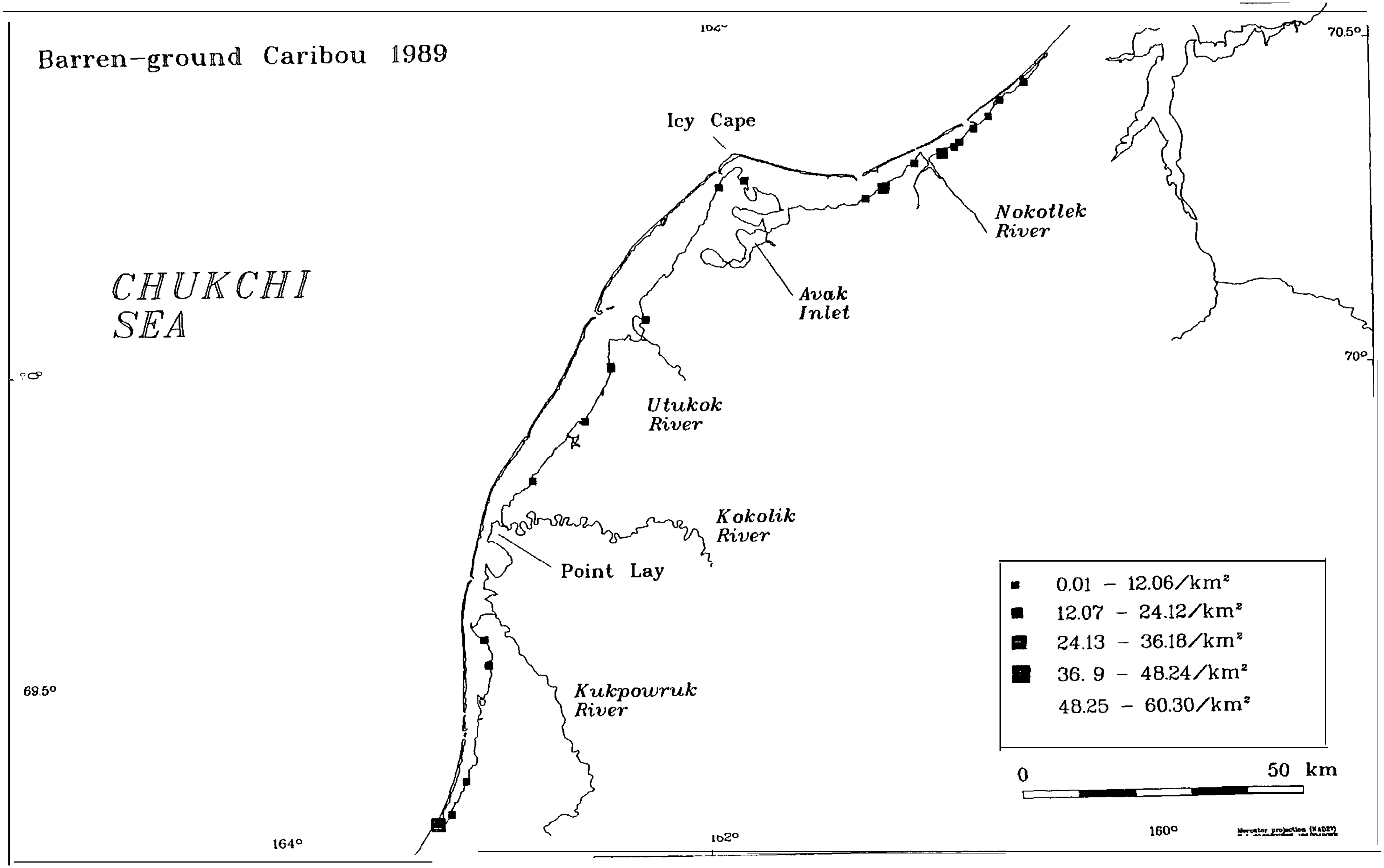


Figure 52. Summary of densities of barren-ground caribou on 1-minute transect segments in the Kasegaluk Lagoon study area in 1989.

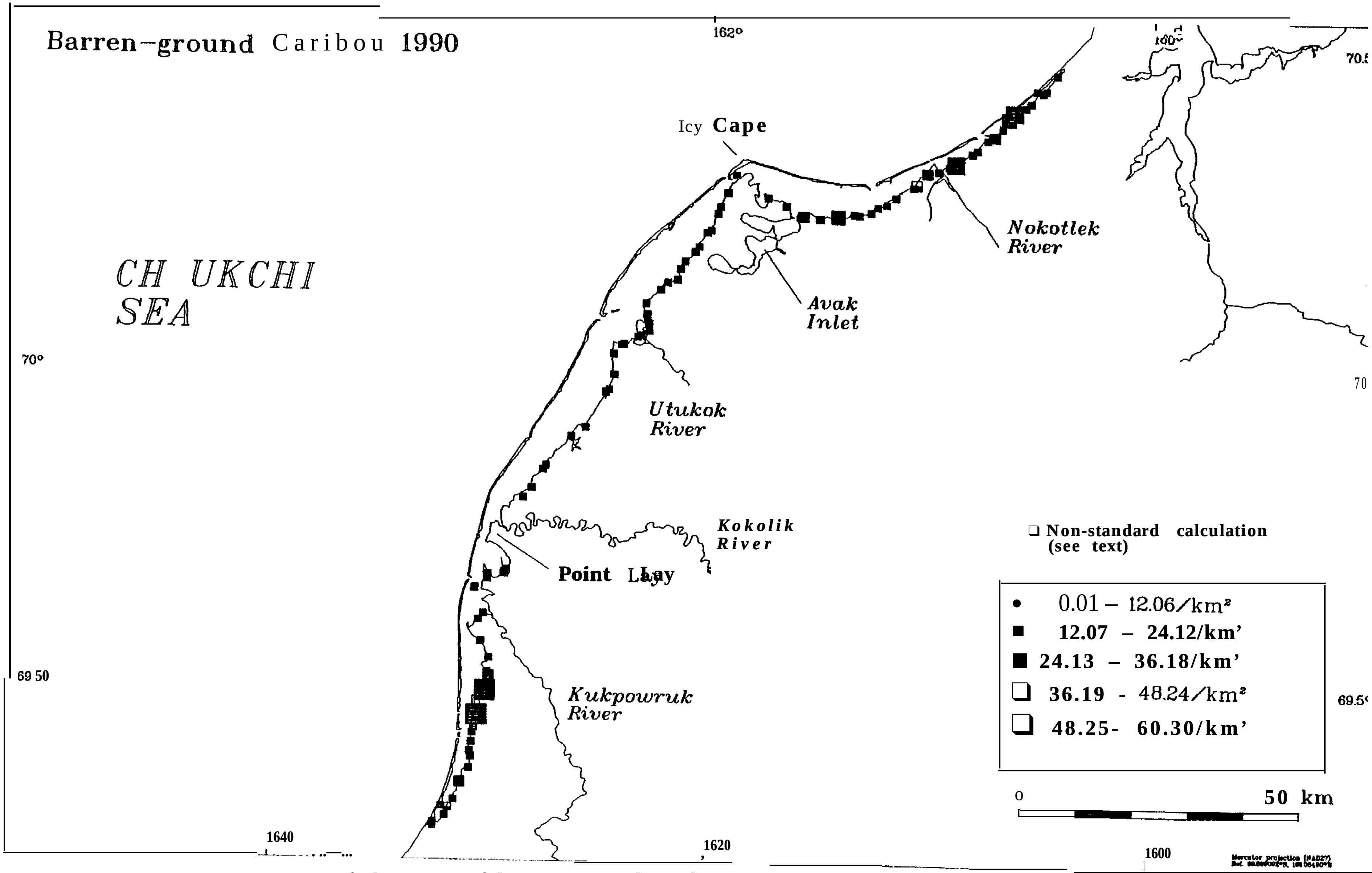


Figure 53. Summary of densities of barren-ground caribou on 1-minute transect segments in the **Kasegaluk** Lagoon study area in 1990.

Table 22. Habitat associations of barren-ground caribou during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-NearShore Marine				
Ocean Beach			55	11.7
Ocean Surf			4	0.9
Lagoon			13	2.8
Lagoon-Mainland margin*			7	1.5
Mid-Lagoon*				
Lagoon-Island margin*			6	1.3
Shoal/Spit				
River Delta			8	1.7
Pond/Lake on Tundra			3	0.6
Tundra	103	100.0	357	76.0
Coastal Marsh			7	1.5
Mudflat			23	4.9
River				
Stream				
All Habitats	103	100.0	470	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category "Lagoon".

Other Terrestrial Mammals

Other terrestrial mammals recorded during the 1989 aerial surveys were several grizzly bears (*Ursus arctos*) and an arctic fox (*Alopex lagopus*) (Table 20). During the 1990 aerial surveys several grizzly bears and a muskox (*Ovibus mosthatus*) were seen (Table 21). Grizzly bears were more abundant in 1990 when a full complement of surveys were flown. Most grizzlies were sighted off-transect along the seaward beaches of the barrier island chain (Figs. 54 and 55; Append. B 17). There were only two sightings of muskoxen, probably the same individual (a large bull), on coastal tundra near the entrance to Avak Inlet in 1990 (Table 21; Fig. 56; Append. B-18). There was only one arctic fox sighted during an aerial survey. It was seen on 11 September 1989 in coastal tundra habitats on the mainland transect (1106) at the far southwestern end of the study area.

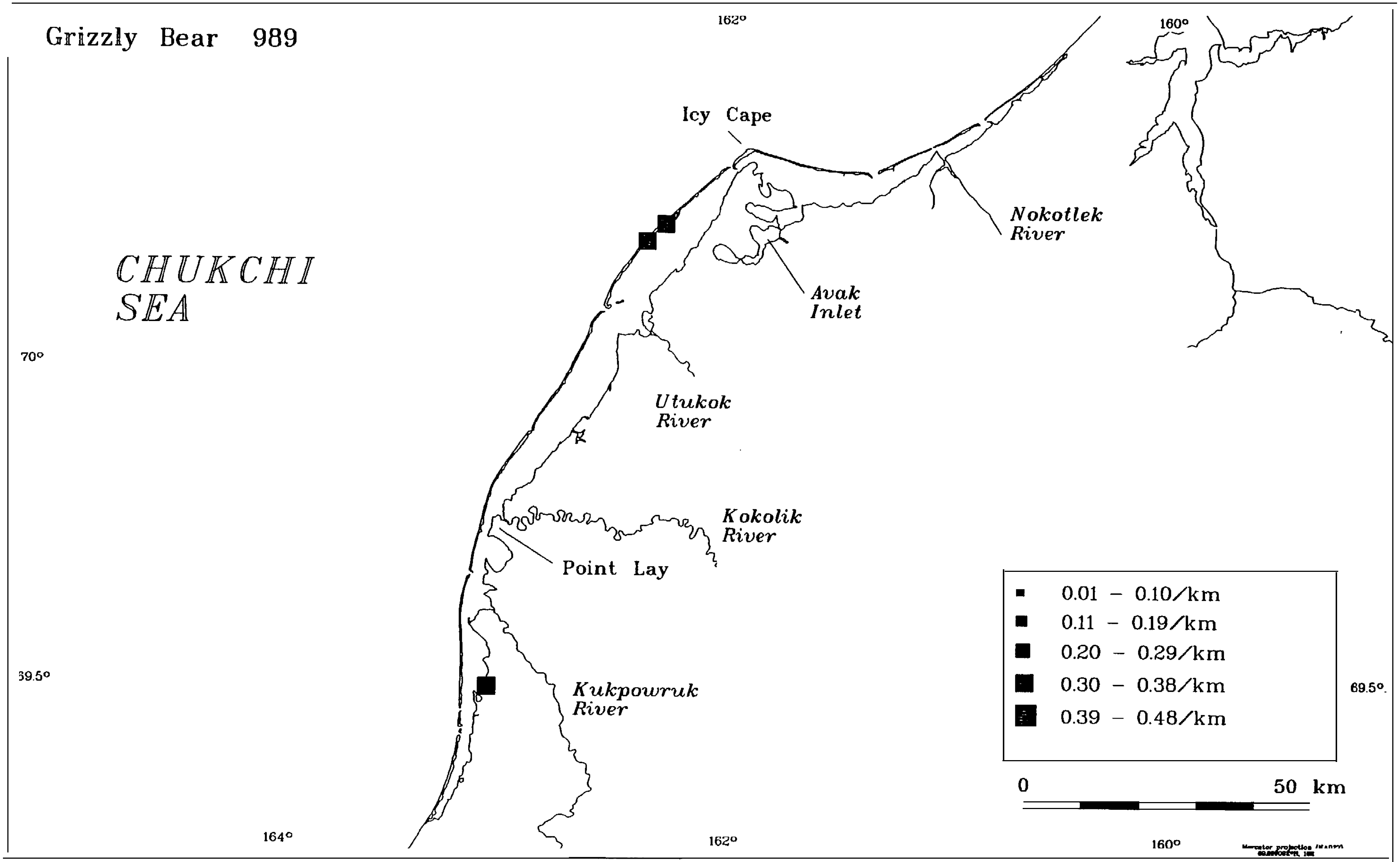


Figure 54. Summary of densities of grizzly bears on 1-minute transect segments in the Kasegaluk Lagoon study area in 1989.

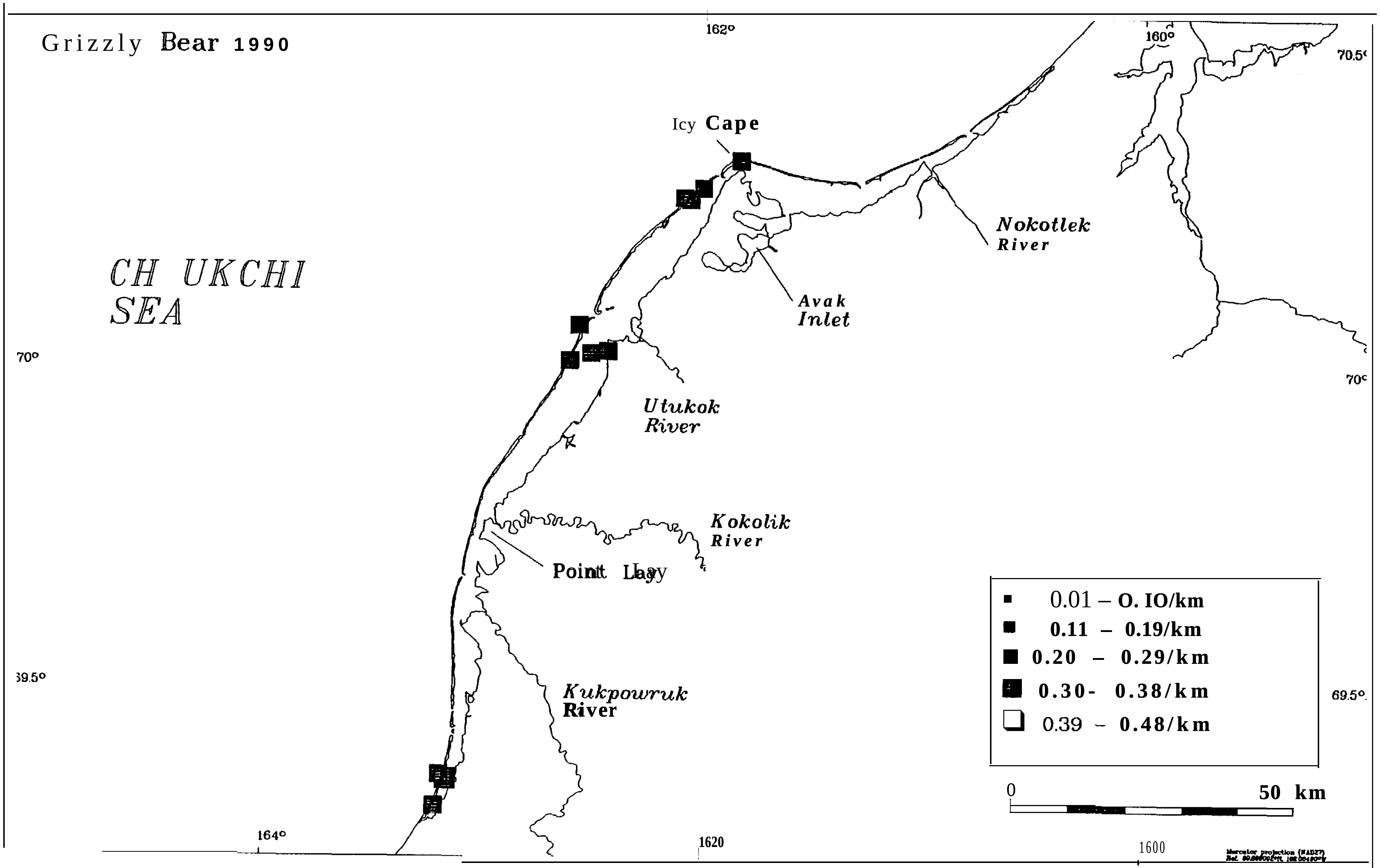


Figure 55. Summary of densities of grizzly bears on l-minute transect segments in the Kasegaluk Lagoon study area in 1990.

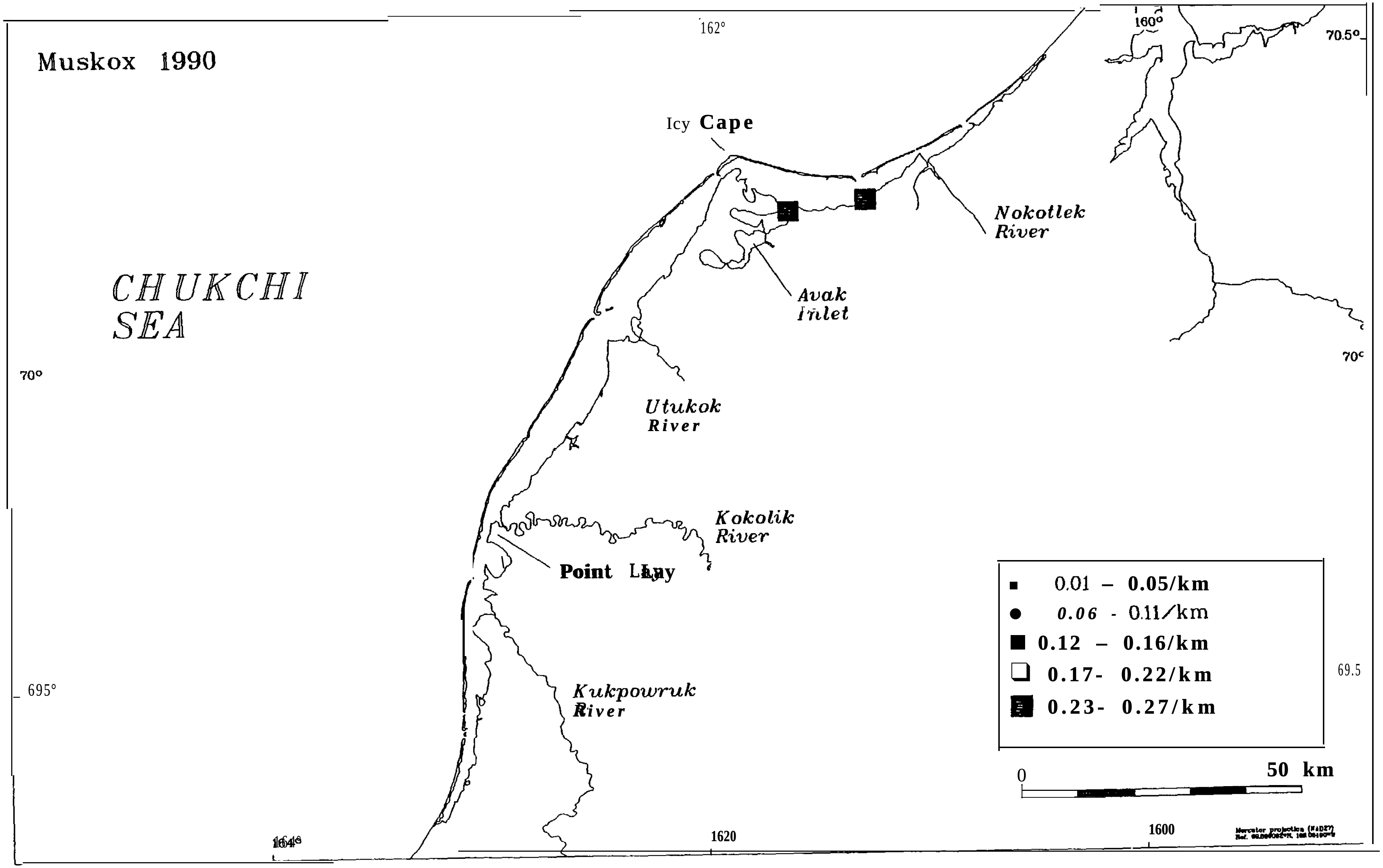


Figure 56. Summary of densities of musk ox on l-minute transect segments in the Kasegaluk Lagoon study area in 1990.

Marine Mammals

Marine mammals were also sighted in the study area during both years of bird surveys. As with birds and terrestrial mammals, all sightings of marine mammals were systematically recorded. Results presented here supplement those of Frost et al. in 'PART II' of this volume. Marine mammals were seen on every bird survey conducted in this study. Five species *or* species groups were recorded in 1989 and seven species or species groups were recorded in 1990. They represented 57.9% of **all** non-bird sightings and 88.7% of all non-bird individuals in 1989. In 1990 they constituted **43.6%** of all non-bird sightings and 83.9% of all non-bird individuals seen (Tables 20 and 21).

Spotted Seal **(Phoca largha)**

Spotted seals were the most abundant marine mammal recorded during both years of aerial surveys. They were counted both in and out of the water at or near specific **haulout** sites in the study area, and in the water farther away from some **haulout** sites. In many instances the same groups of hauled-out seals were counted several times during a single day as the aircraft passed near the **haulout** site. The total numbers of spotted seals presented in Tables 20 and 21 and Fig. 57 include both on- and off-transect individuals counted both in and out of the water at **haulout** sites, plus those counted in the water away from **haulout** sites. Some of these animals would have been counted more than once during a single day of surveys. The number of spotted seals shown in Figures 58 and 59 and in Append. B-19, however, are based solely on seals recorded on-transect. The data in these figures include few seals counted more than once.

In 1989 spotted seals constituted 77.2% (125 of 162) of all marine mammal sightings and 99.170 (4498 of 4498) of all marine mammal individuals recorded during aerial surveys in the study area. Similarly, in 1990 spotted seals made up 97.7% (381 of 390) of all marine mammals sightings and 99.9% (12,023 of 12,032) of all individuals (Tables 20 and 21).

Despite the unequal sampling effort in the two years of aerial surveys, the temporal patterns of spotted seal abundance were similar in both years. The largest numbers of spotted seals recorded on- plus off-transect in the

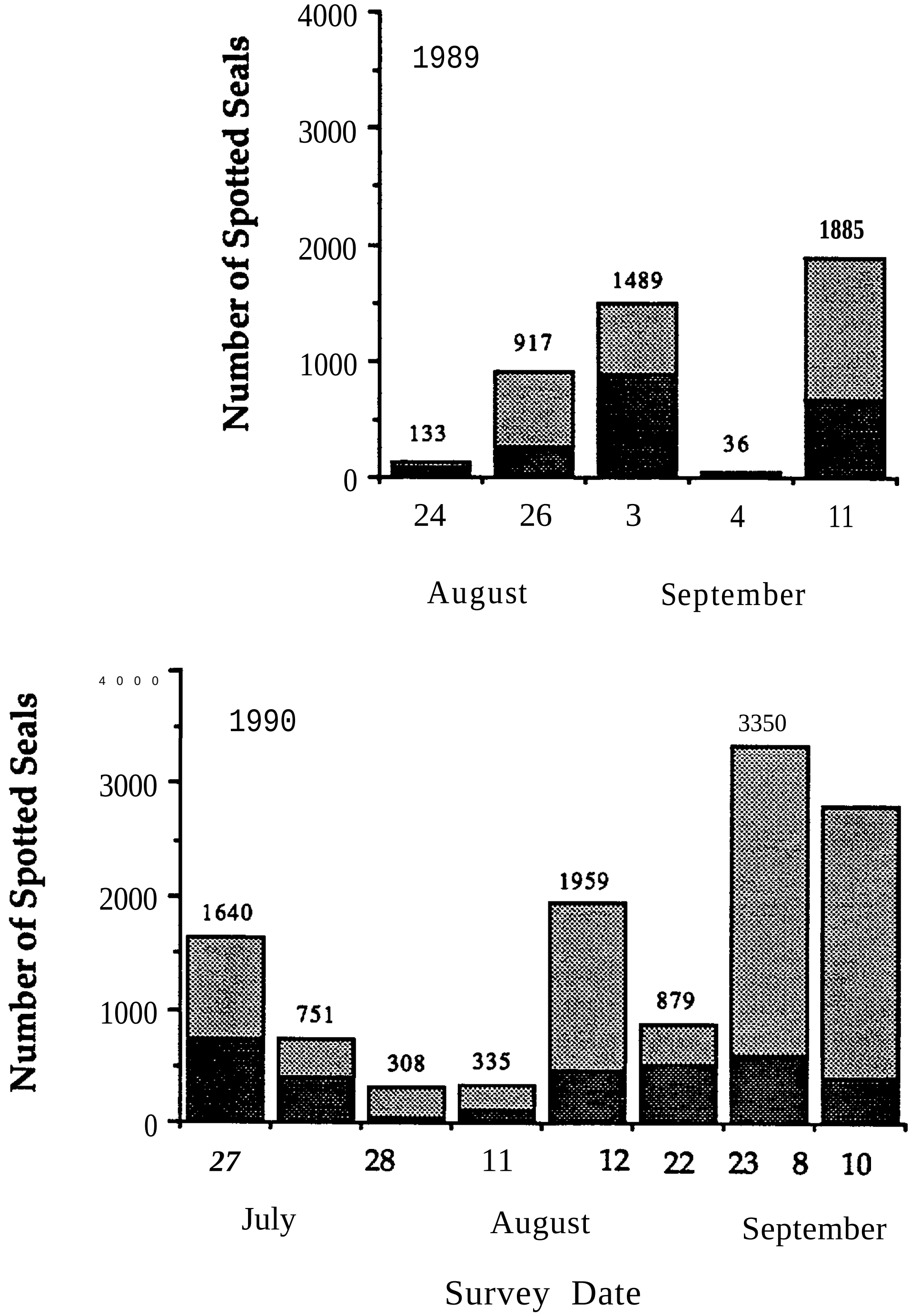


Figure 57. Total number of spotted seals seen both on-transect (heavy stippling) and off-transect (light stippling) on each aerial survey date in 1989 and 1990 in Kasegaluk Lagoon, Alaska. Numbers at the top of each bar are total birds seen on each survey date. Note that survey dates are different in 1989 and 1990. Some transects were not surveyed on 28 July and 11 August 1990 (see 'METHODS' section).

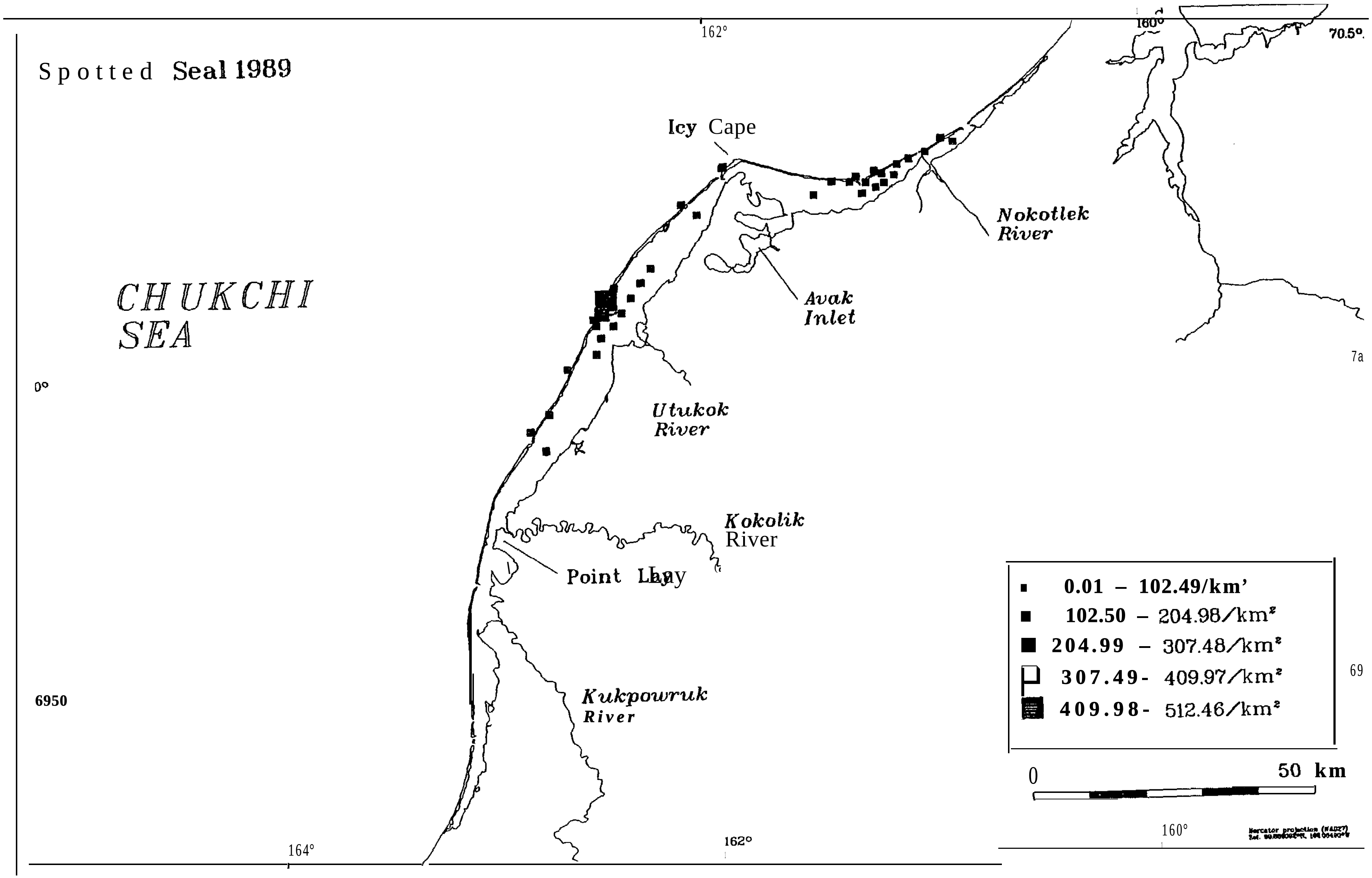


Figure 58. Summary of densities of spotted seals on l-minute transect segments in the **Kasegaluk Lagoon** study area in 1989.

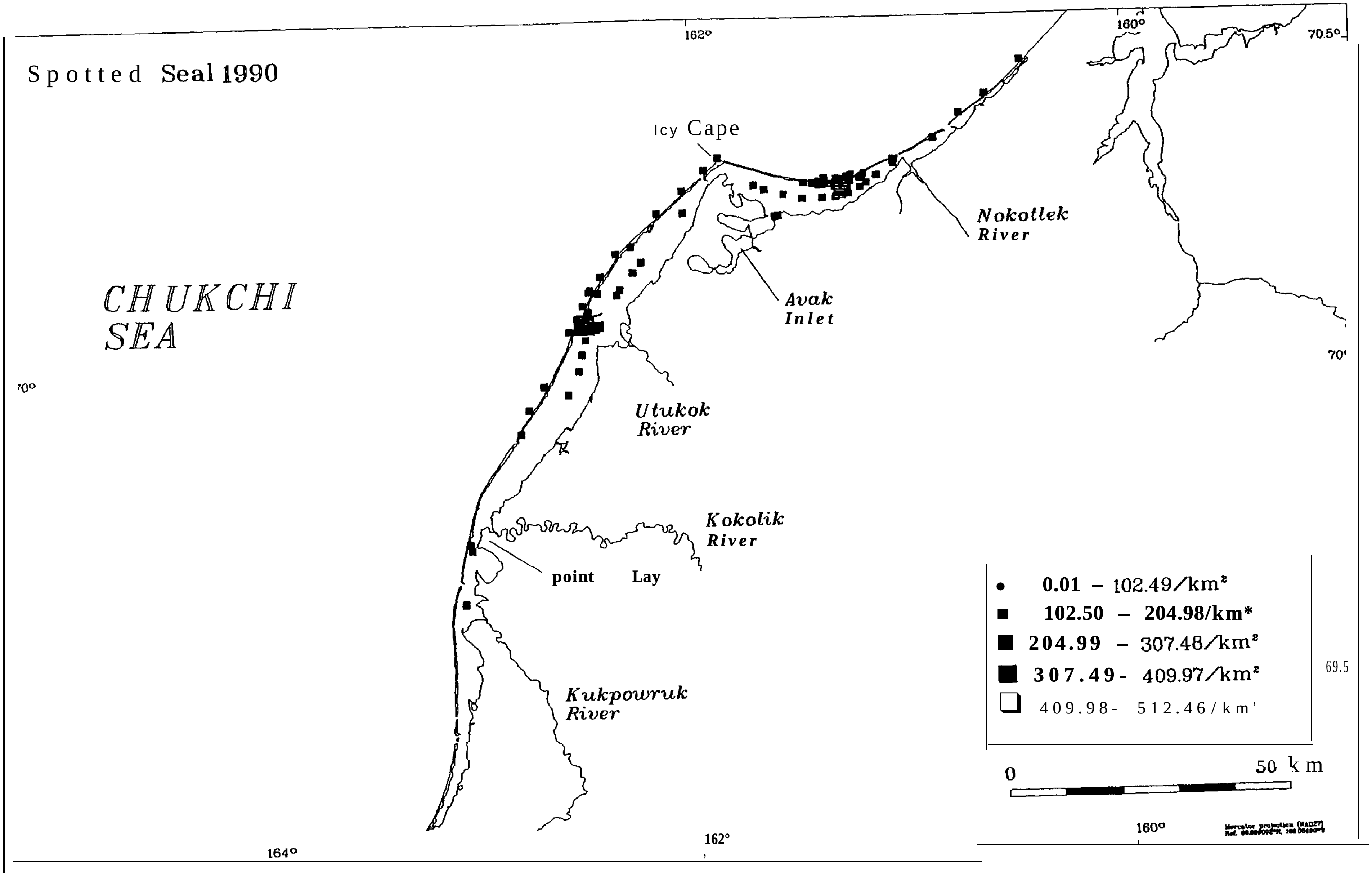


Figure s9. Summary of densities of spotted seals on l-minute transect segments in the **Kasegaluk Lagoon** study area in 1990.

Table 23. Habitat associations of spotted seals during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989		1990	
	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total
Ocean-Nearshore Marine	11	8.8	14	3.7
Ocean Beach	15	12.0	1	0.3
Ocean Surf			1	0.3
Lagoon	96	76.8	340	89.2
Lagoon-Mainland margin*			3	0.8
Mid-Lagoon*	58	46.4	142	37.3
Lagoon-Island margin*	25	20.0	147	38.6
Lagoon Pass*	13	10.4	48	12.6
Shoal/Spit	2	1.6	25	6.6
River Delta				
Pond/Lake on Tundra		-		
Tundra				
Coastal Marsh				
Mudflat				
River	1	0.8		
Stream				
All Habitats	125	100$0	381	100.0

An asterisk (*) indicates that this habitat was a subset of the more comprehensive category "Lagoon".

study area were recorded during the latter part of the survey period, i.e., in September (Fig. 57).

The spatial patterns of abundance of spotted seals were also very similar during the two years of surveys. Peak densities were consistently recorded at or near two locations — at Akoliakatat Pass in the northern part of the study area and at Utukok Pass in the south (Figs. 58 and 59). During bird surveys in 1989, spotted seals consistently were seen near Utukok Pass; the peak density for a l-minute transect segment, 512 seals/sq km, was recorded at this location on 11 September 1989. Remarkably, the peak density for a l-minute transect segment in 1990 was also at Utukok Pass — 507 seals/sq km on 27 July 1990 (Append, B-19). Later in 1990 consistently high densities of spotted seals were recorded farther north at Akoliakatat Pass: 394 and 272 seals/sq km were recorded at this location on 8 and 10 September 1990 (Append. B-19).

Habitat analyses indicated that the largest proportion of spotted seal sightings were in lagoon habitats, mainly in mid-lagoon habitats and along the lagoon-barrier island margin (Table 23). In 1989 a notable proportion of spotted seal sightings were also recorded on ocean beaches and further seaward in nearshore marine waters. In 1990, on the other hand, very few spotted seal sightings were on ocean beaches or in nearshore marine habitats compared to 1989, and notably more sightings were on shoals and spits (Table 23).

Pacific Walrus

A few Pacific walruses (*Odobenus rosmarus*) were also recorded during aerial surveys in 1989 and 1990. Despite the fact that only five surveys were flown in 1989, far more walruses were seen that year compared to 1990 — 16 sightings of 17 walruses in 1989 vs. 3 sightings of 3 walruses in 1990 (Tables 20 and 21; Figs. 60 and 61). In fact, walruses were seen during all five aerial surveys of the study area in 1989, but on only three of the eight surveys in 1990 (Append. B-20). All walrus sightings in both 1989 and 1990 were in ocean beach habitats.

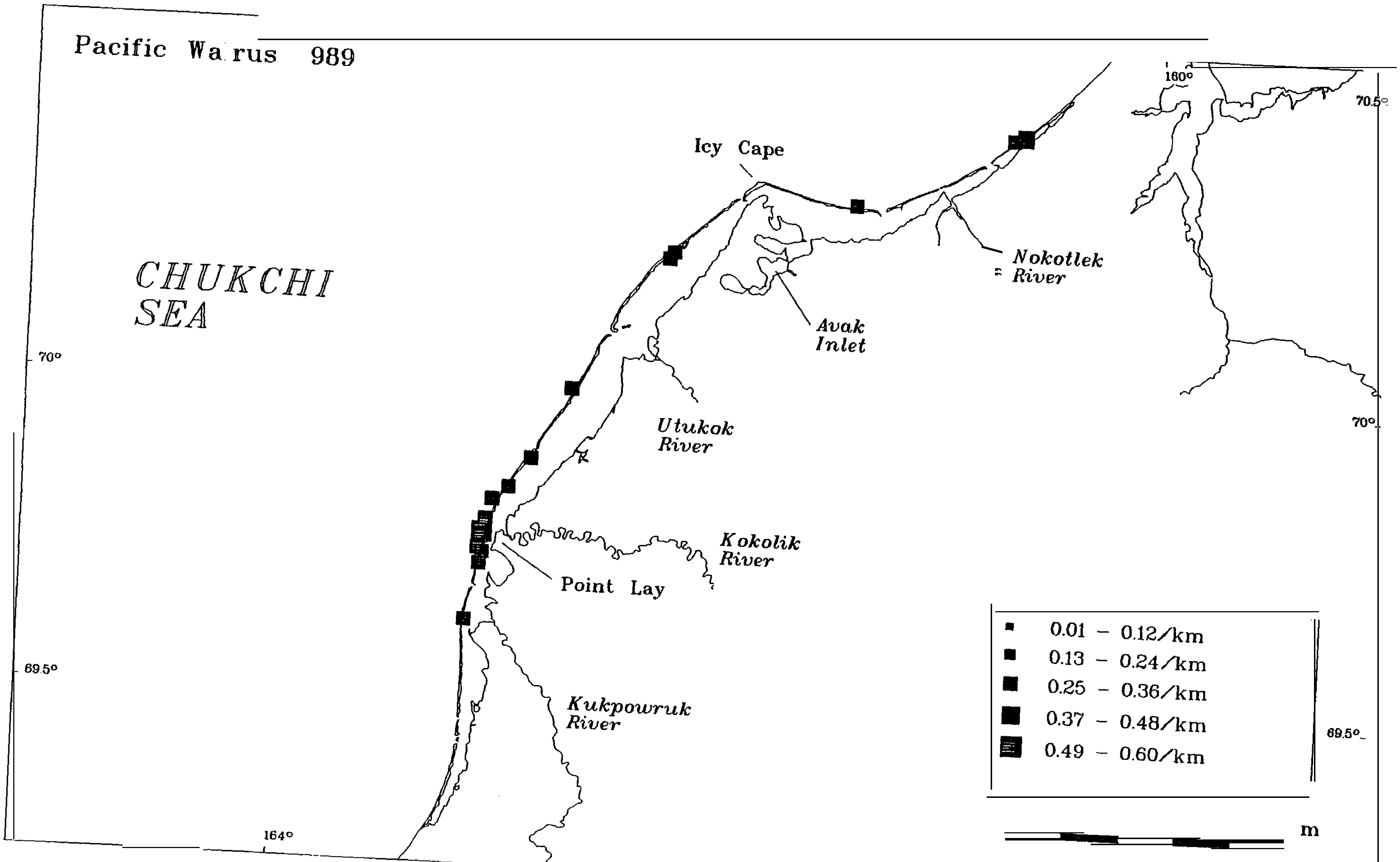


Figure 60. Summary of densities of Pacific walruses on 1-minute transect segments in the Kasegaluk Lagoon study area in 1989.

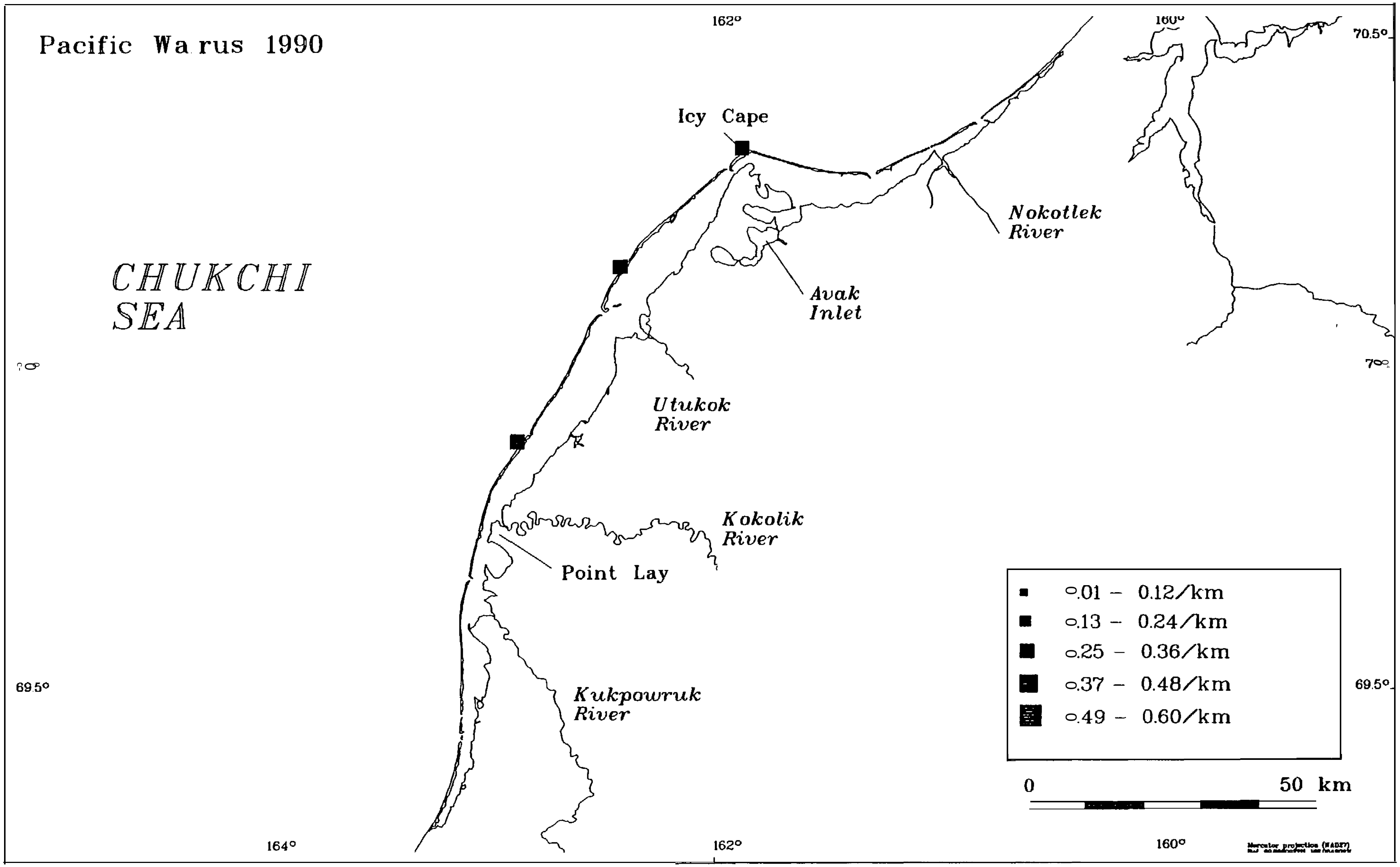


Figure 61. Summary of densities of Pacific walruses ⊂n 1-minute transect segments in the K g k Lagoon study area in 1990.

Other Marine Mammals

The only other marine mammal seen during aerial surveys in 1989 was one ringed seal (*Phoca hispida*) on 11 September in the water at Pingororak Pass, in the northeastern portion of the study area. Another ringed seal was seen offshore from Nokotlek Pass on 10 September 1990 (Table 20).

In 1990 a bearded seal (*Erignathus barbatus*) was seen in Kasegaluk Lagoon adjacent to Pingororak Pass on 8 September, and a single gray whale (*Eschrichtius robustus*) was seen very close to shore (about 50 m) adjacent to Pingororak Pass on 11 August 1990. We saw no other identifiable marine mammals during bird surveys or during ferry flights in the Kasegaluk Lagoon area in either 1989 or 1990 (Table 21).

DISCUSSION

Notwithstanding the very different survey schedules and survey efforts in the two years of this study (Append. A-1), sufficient sampling was conducted to determine the general patterns of bird use of the study area. Although Kasegaluk Lagoon is similar to other barrier island-lagoon systems in Arctic Alaska, certain features of this system and of the bird and mammal uses of the system are distinct from other arctic lagoon systems located farther north and east.

The discussion of key species focuses on the top five ranking bird species (five most abundant) in the study area during 1989 and 1990, with some additional discussion on arctic-nesting geese and on terrestrial mammals seen during bird surveys. The discussions of diversity among arctic lagoon systems compares and contrasts the similarities and differences in bird use of Kasegaluk Lagoon and other Arctic lagoon systems in Alaska, mainly the system of barrier island-lagoons situated along the Central Alaskan Beaufort Sea coast between the Colville River and Canning River deltas. Aerial surveys of about equal sampling effort and intensity were conducted in both of these lagoon systems in 1990 by the same survey crew using the same aircraft and virtually identical sampling techniques.

Key Species in Kasegaluk Lagoon

There were several major differences in the abundance and distribution patterns of birds recorded in the Kasegaluk Lagoon system compared to other arctic lagoon systems. Typically the most abundant species of bird found in Alaskan Arctic lagoons during the summer open-water period are diving ducks, mainly oldsquaws, which use sheltered and food-rich lagoon waters for molting and feeding prior to migration (Johnson and Richardson 1981; Johnson 1983, 1984, 1985; Craig et al. 1984; Garner and Reynolds 1986). In Kasegaluk Lagoon, however, the black brant was overwhelmingly the most abundant species seen in the study area during both years of surveys, especially in 1989. Brant used the lagoon primarily as a stop-over area, apparently for feeding, during their southward migration from molting and nesting locations along the Beaufort Sea coast. Diving ducks, mainly molting oldsquaws, were also very common birds in the Kasegaluk Lagoon system. Arctic terns and glaucous gulls apparently used the Kasegaluk Lagoon system for nesting and feeding; those two species were far more common in Kasegaluk Lagoon than in barrier island-lagoon systems in the Alaskan Beaufort Sea.

Waterfowl were the most abundant and widespread species group of birds recorded in the Kasegaluk Lagoon study area in 1989 and 1990. Prior to the initiation of this study, it had been speculated that large numbers of some species of geese (e.g. brant, white-fronted geese, or possibly emperor geese Anser canagica) may regularly molt in the study area. Aside from a small number of lesser snow geese that probably also nested in the area, we found no evidence of significant numbers of molting geese in the Kasegaluk Lagoon area. Most geese appeared to use Kasegaluk Lagoon for feeding prior to or during southward migration.

Black Brant

About 45% and 15% of the estimated total Pacific Flyway population of brant (about 123,000 birds; C. Dau pers. comm.) were present in the Kasegaluk Lagoon study area during peak periods in 1989 and 1990, respectively (Tables 2 and 3 in 'RESULTS'). Mean linear densities on some transects were nearly 1000 birds/km in 1989 (Append. A-2-1 and A-2-2) Previous to this study, Kasegaluk Lagoon was not known to be a major stop-over location for such large numbers of migrating brant. It was known, however, that brant migrated through the Kasegaluk Lagoon system *en route* to and from molting areas located on the Beaufort Sea coast (Teshekpuk Lake area; Lehnhausen and Quinlan 1982). This migration was speculated to be primarily by an overland route to and from Kasegaluk Lagoon because few brant were seen migrating along the coast in the Peard Bay area, located about 125 km northeast of the Kasegaluk Lagoon system (Gill et al. 1985). In fact, during a ferry flight between Icy Cape and the Colville River delta on 23 August 1990, we saw several large flocks of brant (250-500 birds/flock) totaling several thousand birds in a region of large lakes about 75 km NE of Icy Cape. The brant appeared to be migrating SW toward the Chukchi Sea coast during a period of strong winds from the NE, i.e. strong tailwinds.

The reasons for the marked difference in abundance of brant in the Kasegaluk Lagoon study area during the two years of surveys is unclear. There was some evidence that prolonged SW headwinds associated with storms along the northeastern Chukchi Sea coast may have caused a delay in the southward migration of brant through the study area in August 1989 (Tables 24 and 25). This argument is unconvincing, however, because winds were favorable for southward migration (NW throughout the study area) during about half the peak survey period for brant in late August 1989 (see 24 August survey conditions in Table 24).

There was more convincing evidence that very large quantities of food attracted brant to the northeastern part of the study area in 1989. During aerial surveys, abundant aquatic vegetation was seen along the beaches and in the shallow waters immediately adjacent to transect 1102 (Fig. 2). Although no investigations were conducted to quantitatively measure the abundance of this vegetation, it was evident during aerial surveys of mainland shoreline transects that aquatic vegetation was very abundant in the areas used by the brant in 1989 (i.e., along transect 1102), and was far less abundant in the same area in 1990. Samples that we collected in August 1990 along the beach and in the shallow waters adjacent to transect 1102 indicated that most of the aquatic vegetation was ***sea lettuce* (Ulva sp.)**, a marine green algae.

The different distributions of brant in the study area during the two years, i.e., very concentrated in 1989 vs. more dispersed in 1990, were probably caused by the apparent differences in food availability in the two years. The areas where brant were most concentrated in 1989 (along transect 1102) were adjacent to Nokotlek and Akoliakatat passes. Marine water entering the lagoon system in this area during certain wind regimes may have had an influence on either the growth or the availability of aquatic vegetation in the area.

As mentioned above, there was no evidence from the aerial surveys that large numbers of brant, or any other species of goose, molted in the Kasegaluk Lagoon area during 1989 and 1990.

Oldsquaw

The oldsquaw was considerably less abundant in Kasegaluk Lagoon than we initially expected, based on research in other similar ecosystems

Table 24. Weather and lagoon conditions during five aerial surveys in the north (N) and south (S)* parts of Kasegaluk Lagoon, 24 August through 11 September 1989, Chukchi Sea, Alaska.

Date 1989		Temp. (°c)	Est. Wind Dir.	Est. Wind Spd. (km/h)	Est. Wave Ht. (Inches) Lagoon	Marine	Water Level	Cloud Cover (10ths)
24 August								
	N	8	NW	18-20	8-10	6-10	Low, stable	10
	s	0	NW		8-10	6-10	Low, stable	10
26 August								
	N	6-12	ESE	15	0	0	Low, rising	9
	s	0	Calm	Calm	0	0	Low, rising	9
3 September								
	N	7	Calm	Calm	0	10-12	Med., stable	9
	s	3	E	20	12	10-12	V. low, falling	9
4 September								
	N	4	WNW		6	10	High, rising	10
	s	6	NW	3	3	10	Low, rising	10
10 September								
	N	2	NE	5	8-10	8-10	High, falling	7
	s	3	s	20	12+	8-10	High, falling	9

* North is the area NE of Icy Cape, south is SW of Icy Cape.

Table 25. Weather and lagoon conditions during eight aerial surveys in the north (N) and south (S)" parts of Kasegaluk Lagoon, 27 July through 10 September 1990, Chukchi Sea, Alaska.

Date 1990	Temp. (°C)	Est. Wind Dir.	Est. Wind Spd. (kts)	Est. Wave Ht. (Inches) Lagoon	Marine	Water Level	Cloud Cover (10ths)
27 July							
N	4	N	15	12	6	V. low, falling	5
s	4	N	10-12	6-8		V. low, falling	5
28 July							
N	6	NNE	40-45	**12+**	12+	V. low, falling	3
s	7	NE	**40-45**	12+	**12+**	V. low, falling	3
11 August							
N	20	N	10-15	6-8	**12+**	Low, rising	8
s	20	N	5	3	12+	Low, rising	8
12 August							
N	15	NE	10	6-8	2-3	Mid., rising	10
s	20	E	2-5	3	Calm	Mid., rising	10
22 August							
N	12	w	5	4-5	6-10	V. high, stable	6
s	21	E	5-8	3-5	6	High	6
23 August							
N	**7**	NNE	15-20	6	10- 12+	High, falling	10
s	**9**	Sw	15-18	2	1	High, rising	10
8 September							
N	**1**	w	20	6	**12+**	High, rising	10
s	3	N	15-20	6	**12+**	V. high, rising	10
10 September							
N	3	WSW	8-10	6-8	6-8	High, falling	10
s	4	Sw	10	6-8	6-8	High, falling	10

* North is the area NE of Icy Cape, south is SW of Icy Cape.

farther north and east, and based on studies at Icy Cape in 1981 (Lehnhausen and Quinlan 1982) Peak densities on transects in Kasegaluk Lagoon exceeded 100 birds/sq km only once in 1989 (Append. A-2-3), and exceeded 200 birds/sq km only once in 1990 (Append. A-2-4). In contrast, oldsquaws were by far the dominant species of bird in barrier island-lagoon systems along the Beaufort Sea coast during the summer open water period (Johnson and Richardson 1981, Johnson 1983, Garner and Reynolds 1986). They were also one of the most abundant species recorded in the Peard Bay-Franklin Spit area (about 125 km N of Kasegaluk Lagoon) during the summer open-water period in 1983 (Gill et al. 1985). Similarly, oldsquaws were reported to be relatively abundant in the Icy Cape region of Kasegaluk Lagoon during studies conducted there in 1981 (Lehnhausen and Quinlan 1982).

In Kasegaluk Lagoon, as in lagoons in the Beaufort Sea, most sightings of oldsquaws were of molting males and most sightings were of groups along the barrier island-lagoon margin. A large proportion of sightings in the Kasegaluk Lagoon system were near passes between the lagoon and the Chukchi Sea. This association of molting oldsquaws with lagoon-barrier island margin habitats is typical of similar ecosystems in the Alaskan Beaufort Sea (Johnson 1990). Similarly, the association of oldsquaws with passes between the barrier islands was also evident in some studies in the eastern Alaskan Beaufort Sea (Johnson 1983).

Lesser Snow Goose

There was very strong circumstantial evidence that lesser snow geese nested in the Kasegaluk Lagoon study area. In 1989 the surveys were initiated too late in the season (late August) to determine whether the snow geese had actually nested in the study area. In July of 1990 flocks composed of adults and young-of-the-year snow geese were recorded in the study area (see "RESULTS" for details), with the largest flocks seen in the Kukpowruk River delta (Table 26). Most of these family groups of snow geese were flightless (molting adults and their half-grown goslings), further indicating that the birds had nested in the area.

These findings are important because they document a second nesting location in Alaska for significant numbers of lesser snow geese. Aside from sporadic nesting by a few pairs in the Colville River delta and in the

Table 26. Lesser snow goose sightings in the Kasegaluk Lagoon study area, Chukchi Sea, Alaska, 1989-1990.'

Transect Number	Time Period	Year	Month	Day	Total Birds	Adults	Subad./ Goslings	Group Type	Behavior	Specific Habitat	On/Off
1102	3	1989	08	24	15			Flock	Fly	Lagoon	off
1102	3	1989	08	24	25			Flock	Swim	Tundra	off
1104	4	1989	08	24	35			Flock	Fly	Tundra	off
1206	3	1989	08	24	20			Flock	Fly	Lagoon	off
1301	6	1989	08	24	1			Single	Fly	Lagoon	off
1102	8	1989	08	26	25			Flock	Fly	Lagoon	off
1102	8	1989	08	26	20			Flock	Fly	Tundra	off
1301	5	1989	08	26	25			Fleck	Fly	Lagoon	off
1102	10	1990	07	27	12	12		Flock	Swim	Lake	on
1102	8	1990	07	27	15	13	2	Family	swim	Lake	on
1104	1	1990	07	27	5			Flock	swim	Lake	on
1105	6	1990	07	27	8			Flock	swim	Lake	on
1105	3	1990	07	27	28			Flock	Swim	Lake	on
1105	7	1990	07	27	175	75	100	Family	Swim	Lagoon	off
1205	6	1990	07	27	60			Flock	Stand	Tundra	off
1102	10	1990	07	28	10	8	2	Family	Swim	Lagoon	on
1102	9	1990	07	28	12			Flock	Fly	Tundra	on
1105	2	1990	07	28	19	7	12	Family	Swim	Lake	on
1102	10	1990	08	11	25			Flock	Swim/Fly	Lagoon	on
1102	10	1990	08	11	1			Single	Fly	Tundra	on
1105	8	1990	08	11	160	80	80	Family	Fly	Tundra	on
1102	9	1990	08	12	2			Flock	Fly	Lagoon	On
1105	7	1990	08	12	30			Flock	Fly	Tundra	on
1105	7	1990	08	12	.55	25	30	Family	Fly	Lake	on
1103	6	1990	08	22	6	5	1	Family	Fly	Lagoon	on
1104	8	1990	08	22	75	50	25	Family	Fly	Tundra	on
1102	8	1990	08	23	5			Flock	Fly	Tundra	off
1104	9	1990	08	23	30			Flock	Fly	Tundra	off
1105	2	1990	09	08	180	130	50	Family	Fly	Tundra	On
1105	3	1990	09	10	30		10	Flock	Fly	Tundra	on
1105	2	1990	09	10	90		30	Flock	Fly	Tundra	On

* See Appendix B-7 for daily maps of snow goose distributions in 1989 and 1990.

Teshekpuk Lake area, the only known consistently used nesting location for lesser snow geese in Alaska (and the U. S.) has been on the Beaufort Sea coast at Howe Island, in the Sagavanirktok River delta (Johnson 1991). The precise nesting locations of the snow geese in the Kasegaluk Lagoon study area are presently unknown, but several tundra covered islands with relatively high relief (i.e., above flood waters and away from terrestrial predators) in the outer Kukpowruk River delta are prime candidates.

Glaucous Gull

The glaucous gull is a key bird species in every arctic lagoon system studied in the Beaufort and Chukchi seas. Aside from the Peard Bay-Franklin Spit area (Gill et al 1985), where glaucous gulls comprised nearly 13% of all birds seen during studies in 1983, they were markedly more abundant in Kasegaluk Lagoon than in any arctic barrier island-lagoon system studied.

The abundance and distribution of glaucous gulls in the Kasegaluk Lagoon area in 1990 was confounded by the fact that over 60 beluga whale carcasses were located on the lagoonside beach on the barrier island near Point Lay throughout the study period. These whale carcasses attracted large numbers of glaucous gulls to the study area, as reflected by their overall greater abundance in 1990 compared to 1989, especially early in the season (late July, Fig. 11) and in the area around the village of Point Lay (Transects 1302 and 1303; Figs. 12 and 13, Append. A-2-5 and A-2-6).

Arctic Tern

Arctic terns nest extensively on barrier islands and spits along the Chukchi Sea coast. Gill et al. (1985) found this to be one of the most abundant species at Peard Bay in 1983. Arctic terns were far more abundant and widespread in the Kasegaluk Lagoon system compared to similar areas in the Beaufort Sea. The difference in tern abundance in the two areas was most pronounced in 1990 when a full complement of surveys was flown in both the Chukchi and Beaufort barrier island-lagoon systems (compare Table 3 with Table 27).

Major nesting colonies of arctic terns in the Kasegaluk Lagoon system were located on the grass-covered islets lagoonward of the barrier island chain

Table 27. Total number of bird sightings and individuals seen both on- and off-transect during 11 aerial surveys in the central Alaska Beaufort Sea, 18 July to 5 September 1990.

Species	No. Sightings	% of All Bird Sightings	No. Indiv.	% of All Indiv. Birds
Yellow-billed Loon	16	0.2	20	0.0
Pacific Loon	175	2.2	267	0.1
Red-throated Loon	138	1.7	187	0.0
Unid. Loon	54	0.7	68	0.0
All Loons	383	4.7	542	0.1
Pomarine Jaeger	3	0.0	3	0.0
Parasitic Jaeger	11	0.1	14	0.0
Long-tailed Jaeger	2	0.0	2	0.0
Unid. Jaeger	5	0.1	5	0.0
Black-legged Kittiwake	5	0.1	10	0.0
Glaucous Gull	1,315	16.3	7,994	1.7
Sabine's Gull	14	0.2	87	0.0
Arctic Tern	51	0.6	508	0.1
Unid. Tern	1	0.0	6	0.0
All Seabirds	1,407	17.4	8,629	1.9
Red-breasted Merganser	19	0.2	108	0.0
Northern Pintail	41	0.5	469	0.1
Greater Scaup	2	0.0	45	0.0
Unid. Scaup	2	0.0	15	0.0
Oldsquaw	5,020	62.2	419,258	90.2
Common Eider	704	8.7	14,070	3.0
King Eider	19	0.2	1,165	0.3
Unid. Eider	10	0.1	58	0.0
White-winged Scoter	4	0.0	66	0.0
Surf Scoter	185	2.3	2,856	0.6
Unid. Scoter	9	0.1	160	0.0
Unid. Diving Duck	7	0.1	61	0.0
Lesser Snow Goose	4	0.0	233	0.1
Greater White-fronted Goose	21	0.3	650	0.1
Black Brent	48	0.6	3,445	0.7
Tundra Swan	5	0.1	12	0.0
All Waterfowl	6,100	75.6	442,671	95.3
Red Phalarope	1	0.0	13	0.0
Unid. Phalarope	143	1.8	11,011	2.4
Black-bellied Plover	1	0.0	2	0.0
Lesser Golden Plover	2	0.0	6	0.0
Unid. Plover	1	0.0	5	0.0
Small Shorebird	25	0.3	1,771	0.4
Large Shorebird	4	0.0	14	0.0
All Shorebirds	177	22	12,822	2.8
Willow Ptarmigan	1	0.0	30	0.0
All Ptarmigan	1	0.0	30	0.0
Common Raven	3	0.0	3	0.0
Unid. Passerine	1	0.0	2	0.0
All Passerines	4	0.0	5	0.0

about 5-10 km N of Point Lay (Transect 1303; see Append. B-3, Append A-2-7 and A-2-8). This area was also noted by Kessel and Gibson (unpub. notes Univ. Alaska Museum) and Divoky et al. (1978) to be a major nesting area for large numbers of arctic terns. In 1984 several small groups of Aleutian terns (Sterna aleutica) were also discovered nesting among the arctic terns on these islets (LGL unpub. data). Aleutian terns were positively identified only twice at this location during the present study.

Small Shorebirds

Small shorebirds seen in the study area in 1989 and 1990 were probably of two genera, Phalaropus and Calidris. They were often indistinguishable from the survey aircraft and therefore were often treated as a single taxonomic group. The different behaviors of the two groups (phalaropes swimming and feeding on the surface of the water and sandpipers feeding along beaches and on mudflats), and their different habitat associations suggest that phalaropes were dominant along the lagoon-barrier island margins (Transects 1302-1306 and 1401-1406; Append. A-2-9) and that sandpipers, mainly dunlins and western sandpipers, were dominant on the mudflats at the far SW end of the study area (Transects 1206 and 1301; Append. A-2-1 O). On some occasions, however, it was possible to identify phalaropes swimming over flooded mudflats adjacent to areas occupied by feeding sandpipers.

Red phalaropes, western sandpipers and dunlins were the most abundant shorebirds using the mudflat and marsh habitats around Icy Cape during August and early September in 1981 (Lehnhausen and Quinlan 1982). Similarly, in the Peard Bay-Franklin Spit area red phalaropes and dunlins with lesser numbers of western sandpipers were the three most abundant shorebirds recorded on shoreline transects in mid-July through early September 1983 (Gill et al. 1985) . In the Peard Bay-Franklin Spit area the highest densities of phalaropes were recorded along the Chukchi Sea side of Franklin Spit, and the highest densities of dunlins and western sandpipers were on the Peard Bay side of the spit.

Barren-Ground Caribou

The relatively large number of barren-ground caribou, presumably from the Western Arctic Herd, that were recorded along the mainland coast of Kasegaluk Lagoon, and at times along the lagoon margins of both the mainland and barrier islands, indicated that the study area is probably used as insect-relief habitat by this species. Large numbers of caribou were often seen standing in the lagoon or along the beaches during surveys in late July through August, especially in 1990. Similar behavior by caribou has also been noted along the Beaufort Sea coast.

Grizzly Bear

The regular sightings of grizzly bears in the Kasegaluk Lagoon study area was a marked difference between this barrier island-lagoon system and similar systems along the Central Alaskan Beaufort Sea coast. Based on observations of both bears and bear tracks, grizzlies appeared to move into the Kasegaluk Lagoon study area from the south, i.e., from the foothills of the De Long Mountains. Most bears passed through the study area along the barrier islands. On several occasions grizzly bears were observed feeding on marine mammal carcasses on the barrier islands. It is probable that bears traditionally move to this section of the Chukchi Sea coast to take advantage of the abundant food source provided by marine mammal carcasses (W. Neakok pers. comm.). The relatively large number of bear tracks seen on the mudflats between the barrier islands and the mainland at Icy Cape suggested that grizzlies often crossed to and from the mainland in this area.

Habitat Associations

There was no sea ice in or near the Kasegaluk Lagoon study area in either 1989 or 1990 when bird aerial surveys were conducted. (This was not the case for the marine mammal part of this study, which began in early July 1990; see Frost et al. in 'PART II' of this volume, for more details.) Therefore there were few or no ice-associated bird species (e.g., black guillemot, black-legged kittiwake, thick-billed murre, ivory gull, Ross' gull, etc.) recorded during the bird surveys. This is in contrast to the situation at Peard Bay-Franklin Spit in 1983 when similar surveys of birds were conducted; sea ice was still present in that more northern study area when investigations commenced in mid-July (Gill et al. 1985).

Habitat associations in this study were based mainly on the particular habitat type recorded in the immediate area of the bird sighting, and on the habitat type recorded on the l-minute transect segment. Habitat preferences were based on comparisons of the proportions of bird sightings in various habitat types relative to the seasonal mean proportions of those habitats on 1-minute transect segments. Preferences were computed only for 1990 when a full season of sampling was conducted.

Bird habitats in most of the Kasegaluk Lagoon study area were characterized by dynamic changes from one day to the next and from one area to another. Prevailing winds were often from different directions on different survey days (and in different parts of the study area), thereby causing lagoon water levels along some transects or transect segments to fluctuate rapidly from one survey to the next (or from one end of the transect to other). These types of dynamic changes were most prevalent along the lagoon-barrier island margin (transects 1301-1306), along the lagoon-mainland margin (1101-1106), and to a lesser extent along mid-lagoon transects (1201-1206). For example, areas of mudflat habitat used by thousands of shorebirds on a mid-lagoon transect on one day could be covered by several centimeters of water the next day, thus temporarily eliminating large areas of shorebird feeding habitat, and thereby dramatically affecting counts of shorebirds in mudflat habitats on that transect. Standard habitat classification schemes were not appropriate in such a dynamic system, thus it was difficult to quantify the various habitat types available to birds in a large part of the study area (i.e., on most lagoon transects).

In the Kasegaluk Lagoon study area about half of all bird sightings were in lagoon habitats (55.6% and 42.8% in 1989 and 1990, respectively; Table 28), a proportion very similar to that estimated to be available (about 54%; Table 29). The largest proportion of sightings was recorded in the narrow strip of lagoon habitat along the barrier island margin (25.6% and 24.3% in 1989 and 1990, respectively). The majority of species using this habitat in both years were waterfowl (mainly oldsquaws) and seabirds (glaucous gulls and arctic terns). Overall, however, use of this habitat was not significantly different from that expected on the basis of habitat availability (Table 29).

Habitats used frequently by birds were the seaward beaches of barrier islands (ocean beach), primarily by glaucous gulls and brant (in 1990). Mudflat habitats were used primarily by small shorebirds, and nearshore marine habitats were used primarily by scoters and eiders. Of the five key species whose habitat preferences were examined in detail, only the oldsquaw duck and arctic tern showed marked or statistically significant concentrations around passes in the barrier islands (18.2% and 13.670 of sightings, respectively, in 1990; Table 29). There were no statistically significant concentrations of key bird species in nearshore marine or mid-lagoon habitats. In fact, significant y fewer sightings than expected were recorded in mid-lagoon habitats. Small shorebirds and arctic terns both showed a statistically significant preference for mudflat habitats, while oldsquaws tended to avoid this habitat (Table 29).

Habitat associations by brant during the two years of study were confounded by the fact that the sampling periods and intensity were different in the two years, and therefore were not directly comparable. Nevertheless, it appeared that the proportion of brant sightings in lagoon vs. ocean habitats was markedly different during the two years. Over 6070 of all brant sightings in 1989 were along the lagoon margins (29.7$10 along the lagoon-mainland margin and 30.6% along the lagoon-barrier island margin). In 1990, on the other hand, far more brant sightings were along the margins of the barrier islands (42.8% along the oceanside beaches and 27.6% along the lagoon-barrier island margin), and far fewer than in 1989 were along the lagoon-mainland margin (only 5% in 1990 compared to 29.7% in 1989). As mentioned earlier, the availability of aquatic vegetation along the mainland shoreline in the far northeastern portion of Kasegaluk Lagoon appeared to be the main factor related to the different habitat uses by brant in 1989 vs. 1990.

Table 28. Habitat associations of all birds recorded during aerial surveys of **Kasegaluk** Lagoon, **Chukchi** Sea, Alaska, in 1989 and 1990.

Specific Habitat Type	1989 Number of Sightings	1989 Percent of Total	1990 Number of Sightings	1990 Percent of Total
Ocean-Nearshore Marine	610	18.8	1282	17.7
Ocean Beach	318	9.8	968	13.4
Ocean Surf	52	1.6	237	3.3
Lagoon	1807	55.6	3096	42.8
Lagoon-Mainland **margin***	382	11.8	223	3.1
Mid-Lagoon*	382	11.8	570	7.9
Lagoon-Island **margin***	833	25.6	1758	24.3
Lagoon Pass*	210	6.5	545	7.5
hoa Sp	3	0.1	65	0.9
River Delta	8	0.2	39	0.5
Pond/Lake on Tundra	66	2.0	253	3.5
Tundra	191	5.9	591	8.2
Coastal Marsh	65	2.0	128	1.8
Mudflat	122	3.8	564	7.8
River	**1**	0.0	6	0.1
Stream	5	0.2	**13**	0.2
All Habitats	3248	100.0	7242	100.0

An asterisk (“) indicates that this habitat was a subset of the more comprehensive category “Lagoon”.

Table 29. Habitat preferences of key bird species recorded during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1990.

Specific Habitat Type	Average **Habitat Availability** (% Expected)	**Observed Habitat Use (% of Sightings in 1990)**					
		Black Brant	**Oldsquaw** Duck	**Small** Shorebird	**Glaucous** Gull	Arctic Tern	All Birds
Ocean-Nearshore Marine	12.9	***1.9***	6.4	0.0	7.3	3.5	17.7
Ocean Beach	4.2	***42.8***	0.9	2.3	20.1	S.9	13,4
Ocean Surf	8.5	***4.0***	***0.6***	1.8	7.1	0.8	3.3
Lagoon-Mainland margin	10.3	***5.0***	***1.1***	***1.3***	2.0	0.1	3.1
Mid-Lagoon	20.2	***4.4***	23.0	3,6	3.4	2.9	7.9
Lagoon-Island margin	19.4	***27.1***	46.2	26.1	34.9	47.6	24.3
Lagoon Pass	**4.4**	***0.5***	18.2	0.3	7.2	13.6	7.5
Shoal/Spit	0.1	***0.5***	0.4	0.3	1.9	***1.3***	0.9
River Delta	2.4	***0.3***	0.3	0.3	0.2	0.4	0.5
Pond/Lake on Tundra	0.4	***0.8***	1.4	3.4	0.7	0.6	3.5
Tundra	9.9	***5.2***	0.0	21.2	6.0	4.3	8.2
Coastal Marsh	2.0	***1.7***	0.9	6.5	0.9	2.9	1.8
Mudflat	4.8	***5.4***	0.5	32,8	8.2	13.0	7.8
River	0.4	***0.0***	0.0	0.0	0.0	0.0	0.1
Stream	0.1	***0.3***	0.1	0.3	0.1	0.0	0.2
All Habitats	100	100	100	**100**	100	100	100
Chi-Square		395.1	**222.1**	258.6	137.3	138.5	75.5
d.f.		14	14	14	14	14	14
P		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Observed proportions in boldface italics are significantly different from the expected proportions ($p \leq 0.05$, d.f. = 1).

Avian Species Diversity in Alaskan Arctic Lagoons

The richness and diversity of bird species in the Kasegaluk Lagoon system is much greater than we antiapated at the start of this study, and it is markedly greater than in other lagoon systems that have been studied in Arctic Alaska. The most striking comparison is between Kasegaluk Lagoon and similar systems along the Central Alaskan Beaufort Sea coast, i.e., Simpson Lagoon and Leffingwell Lagoon (Table 30). There is a large historical base of data for these Central Beaufort lagoons, but the best comparisons are from 1990 aerial surveys that were conducted in both areas using the same sampling procedures and personnel. Data from studies of other Arctic Alaska lagoon systems (Gill et al. 1985; Brackney et al. 1985) have also been reanalyzed and are presented here for comparative purposes (Table 30).

Bird use of barrier island-lagoon systems in the Alaskan Beaufort Sea is overwhelmingly dominated by one species, the oldsquaw duck. Oldsquaws using lagoons in the Beaufort Sea are primarily molting and feeding males. This single species has comprised nearly 92% of all birds recorded both on- and off-transect during aerial surveys conducted over a period of 10 years from 1977 through 1990. In 1990, the proportion of oldsquaws in these central Beaufort Sea lagoons was also over 90% (Table 30). Farther east, in lagoons along the coast of the Arctic National Wildlife Refuge (ANWR), oldsquaws made up nearly 80% of all birds recorded during aerial surveys. The overwhelming dominance of Alaskan Beaufort lagoon systems by a single species has a strong influence on the index of diversity computed for these systems (Table 30). Beaufort Sea lagoons are also used by shorebirds (mainly phalaropes) for pre-migratory feeding, and by small populations of glaucous gulls, arctic terns, common eiders, and brant (Johnson and Richardson 1981; Craig et al. 1984).

The Peard Bay-Franklin Spit area, studied extensively in 1983 (Gill et al. 1985), was intermediate in bird species richness and diversity compared to the Beaufort Sea lagoons and the Kasegaluk Lagoon system. A dominant species in Peard Bay was the oldsquaw duck, although the Franklin Spit area also attracted large numbers of seabirds, such as the black-legged kittiwake (Table 30). Kittiwakes using this area probably originated from the colonies at Cape Thompson and Cape Lisburne, located about 200 km southwest of Peard Bay.

Table 30. Comparisons of various characteristics of barrier island-lagoon systems **in the Beaufort Sea and Chukchi Sea, Alaska.**

Characteristics		Central Alaska Beaufort Lagoons (1990) [a]		11 ANWR Lagoons (1983) [b]		Peard Bay (1983) [c]		Kasegaluk Lagoon (1990) [a]	
Species Richness [d]			29		24		37		48
Shannon-Wiener 'H' [e]			0.1742		0.3417		0.7723		0.8442
Relative Abundance (%) of Top Five Ranking Species or Species Groups	1	Oldsquaw	90.20	Oldsquaw	78.87	B-1 Kittiwake	27.63	Black Brant	38.1
	2	Common Eider	3.00	Sm. Shorebird	13.92	Oldsquaw	27.13	Oldsquaw	15.2
	3	Sm. Shorebird	2.80	Black Brant	2.18	Arctic Tern	19.13	Sm. Shorebird	14.0
	4	Glaucous Gull	1.70	Glaucous Gull	2.04	Glaucous Gull	12.59	Glaucous Gull	7.1
	5	Black Brant	0.70	Arctic Tern	1.25	Black Brant	4.97	Arctic Tern	5.2

a Central Beaufort Lagoons and Kasegaluk Lagoon data are from aerial surveys during 27 July-10 September 1990 (this study).

b Arctic National Wildlife Refuge (ANWR) data are from aerial surveys during 4 August-8 September 1983 (Brackney et al. 1985:Append.).

c Peard Bay data are from aerial surveys of shorelines and open lagoon habitats during 15 July-25 August 1983 (Gill et al. 1985).

d "Species Richness" is simply the total number of identifiable species recorded during the aerial surveys. Small Shorebirds was the only 'species-group' included in this measure.

e Shannon-Wiener Diversity Index, $H= -\Sigma (p\ )(\log p\ )$, see Pielou (1974:290).

Overall, kittiwakes were equal in abundance to oldsquaws in the Peard Bay-Franklin Spit area. Other marked differences in the Peard Bay-Franklin Spit system (compared to lagoons in the Alaskan Beaufort Sea) were the high densities of glaucous gulls and arctic terns on Franklin Spit.

The reasons for the greater avian species richness and diversity in Kasegaluk Lagoon (and Peard Bay) compared to similar lagoon systems located in the Alaskan Beaufort Sea are unclear, but are probably related to climate, oceanography, proximity to the De Long Mountains, and the general physiography and orientation of the coastline in the Kasegaluk Lagoon area (Brewer et al. 1977, Hale 1987). This region of the Chukchi Sea is characterized by a northward flow of the relatively warm Alaska Coastal Water mass, which is heavily influenced by discharges from the Yukon and Kuskokwim rivers (Coachman and Aagaard 1981, Lewbel and Gallaway 1984). Mean air temperatures in May and June are higher in the study area than along the Beaufort Sea Coast (Brewer et al. 1977). The warm coastal waters and prevailing northwestward currents along this section of the Chukchi Sea coast cause shorefast ice to depart from this area earlier than it does in the Beaufort Sea (Brewer et al. 1977, Hale 1987). The Kukpowruk, Kokolik, Utukok and Nokotlek rivers, which drain runoff from summer storms in the nearby De Long Mountains, probably greatly reduce the salinity of Kasegaluk Lagoon, much of which is thought to be considerably more brackish and productive than lagoons in the Alaskan Beaufort Sea (Roseneau and Herter 1984, l?. Craig pers. comm).

The SW-NE orientation of the coastline in the Kasegaluk Lagoon area, coupled with the prevailing NE winds and SW storms in the area play a key role in the mass transport of water onto and away from the coast (Pease 1987). The predominant direction of water movement along this section of the Chukchi Sea coast is northeastward, forced primarily by Bering Sea Water influx. Adjacent to some stretches of coast, a baroclinic coastal jet parallels the coast in the direction of the wind. Upwelling of relatively cold and saline outer shelf water into coastal areas probably occurs under strong NE winds (Lewbel and Gallaway 1984); this may increase productivity in the area. Most severe storms along this section of coast are from the SW; longshore flow rates as high as 200 cm/s and positive rises in sea level ranging from 1.8 to > 3 m have been recorded during southwesterly storms, but less severe rises are more typical (Lewbel and Gallaway 1984) These factors appear to be the major forces behind the dynamic changes in water levels and that affect bird habitat availability and bird abundance in the Kasegaluk Lagoon system,

SUMMARY AND CONCLUSIONS

Aerial surveys of Kasegaluk Lagoon in 1989 and 1990 indicated that waterfowl were by far the most abundant group of birds present in the area, notwithstanding different sampling efforts during the two years. In 1989 over half (57.7%) of all bird sightings and over 95% of all individual birds recorded were waterfowl, mainly black brant (16.7% of all sightings and 70.2% of all individuals) and oldsquaws (14.770 of sightings and 12.0% of individuals). Waterfowl also comprised a large proportion of bird sightings and individuals in 1990 (41 .7% and 69.170, respectively), and the largest proportion were again brant (1 1.8% of sightings and 38.1 '%0 of individuals) and oldsquaw (11.0% of sightings and 15.2% of individuals). Brant used the lagoon during mid- to late August through early September primarily for staging (feeding and resting) prior to continuation of their southward migration. Oldsquaws using the lagoon were primarily molting males, as in other Alaskan Arctic lagoon systems.

Glaucous gull, arctic tern and small shorebirds were also present in the Kasegaluk Lagoon system in large numbers and these species were also considered to be key species. Glaucous gulls nested on the barrier islands and grassy islets along the lagoon barrier island margin, and were more common and concentrated in late July-early August 1990 when several dozen whale carcasses were present along the lagoonside beach of the barrier island adjacent to Point Lay. Arctic terns, and a small number of Aleutian terns, also nested in the study area, mainly on the barrier islands and on the grass-covered islets 5-10 km northwest of Point Lay.

About half of all bird sightings during both years of surveys were in lagoon habitats, mainly along the lagoon-barrier island margins. Nevertheless, three of the five key species examined in detail in 1990 (brant, glaucous gull and arctic tern) plus 'All Birds' showed a preference for 'Ocean Beach' habitat. Only the oldsquaw and arctic tern showed a preference for the passes joining the lagoon with the nearshore Chukchi Sea. Arctic terns and small shorebirds showed a strong preference for mudflat habitats exposed during strong northerly or northeasterly winds. Under these conditions mudflats were exposed mainly in shallow regions of the lagoon, i.e., in the extreme southwestern part of the study area (south of Neakok Pass) and in the area immediately east of Icy Cape. Only small shorebirds showed a preference for coastal marsh habitats.

Although several key bird species recorded during aerial surveys of Kasegaluk Lagoon (oldsquaw, glaucous gull, small shorebird) are also key bird species in other Alaskan Arctic lagoon systems, the most abundant species of bird recorded in Kasegaluk Lagoon, the black brant, has not been a key bird species in similar barrier island-lagoon systems studied in the Alaskan Arctic.

Both the richness and diversity of bird species using Kasegaluk Lagoon were greater than we anticipated at the outset of this study. The species richness and species diversity indices computed for Kasegaluk Lagoon (48 and 0.844, respectively) and the Peard Bay-Franklin Spit area (37 and 0.772, respectively) were over 100% greater than those computed for similar Beaufort Sea lagoon systems. In the Beaufort Sea one species, the oldsquaw duck, has made up over 90% of all bird sightings during 10-years of surveys. The overwhelming dominance by a single species in Beaufort Sea lagoon systems is reflected in the low species richness and low species diversity for this area — 29 and 0.174, respectively, for Central Beaufort Sea lagoons, and 24 and 0.342, respectively, for 11 ANWR lagoons. All of these lagoon systems were sampled using similar aerial survey sampling procedures.

In conclusion, based on current information from the literature and from two years of aerial surveys, we have not been able to refute the research hypothesis presented at the outset of this study ***"Kasegaluk Lagoon supports special habitat uses by vertebrates, uses that are not duplicated in lagoon habitats elsewhere in the Alaskan Arctic."*** Compared to other lagoons elsewhere in Arctic Alaska, Kasegaluk Lagoon does support special habitat uses by vertebrates, The large number of brant that use the study area makes it distinct from other Arctic Alaska lagoon systems. The large number of spotted seals and belugas present in the study area, as discussed in the next chapter (PART II), further exemplify the distinct nature of Kasegaluk Lagoon.

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Appendix A-1. Information About Aerial Surveys in Kasegaluk Lagoon, Chukchi Sea, Alaska, 1989-1990.

Appendix A-1. Information about aerial surveys in the Kasegaluk Lagoon area, Chukchi Sea, Alaska, 1989 and 1990.

Survey Date	Transect No.	Transect Length (km)	Transect Width (m)	Start Time	End Time
24 Aug. 1989	1105	33.9	400	1325	1335
24 Aug. 1989	1106	24.7	400	1335	1343
24 Aug. 1989	1301	22.3	400	1344	1350
24 Aug. 1989	1302	34.1	400	1350	1401
24 Aug. 1989	1303	42.7	400	1401	1415
24 Aug. 1989	1304	28.0	400	1415	1428
24 Aug. 1989	1305	43.9	400	1428	1435
24 Aug. 1989	1306	28.2	400	1435	1452
24 Aug. 1989	1101	27.7	400	1453	1459
24 Aug. 1989	1102	39.8	400	1500	1512
24 Aug. 1989	1103	35.9	400	1512	1523
24 Aug. 1989	1104	37.7	400	1523	1524
24 Aug. 1989	1205	33.4	400	1613	1621
24 Aug. 1989	1206	22.9	400	1621	1629
24 Aug. 1989	1401	20.9	400	1629	1635
24 Aug. 1989	1402	33.8	400	1635	1645
24 Aug. 1989	1403	42.4	400	1645	1659
24 Aug. 1989	1404	32.5	400	1659	1711
24 Aug. 1989	1405	37.5	400	1711	1721
24 Aug. 1989	1406	28.3	400	1721	1736
24 Aug. 1989	1201	15.2	400	1739	1744
24 Aug. 1989	1202	38.1	400	1744	1755
24 Aug. 1989	1203	33.3	400	1755	1803
24 Aug. 1989	1204	40.4	400	1803	1816
26 Aug. 1989	1105	33.9	400	1503	1514
26 Aug. 1989	1106	24.7	400	1514	1523
26 Aug. 1989	1301	22.3	400	1524	1530
26 Aug. 1989	1302	34.1	400	1530	1538
26 Aug. 1989	1303	42.7	400	1538	1550
26 Aug. 1989	1304	28.0	400	1550	1559
26 Aug. 1989	1305	43.9	400	1559	1608
26 Aug. 1989	1306	28.2	400	1608	1623
26 Aug. 1989	1101	27.7	400	1624	1633
26 Aug. 1989	1102	39.8	400	1633	1643
26 Aug. 1989	1103	35.9	400	1643	1655
26 Aug. 1989	1104	37.7	400	1655	1710
26 Aug. 1989	1205	33.4	400	1745	1755
26 Aug. 1989	1206	22.9	400	1755	1803
26 Aug. 1989	1401	20.9	400	1804	1810
26 Aug. 1989	1402	33.8	400	1810	1818
26 Aug. 1989	1403	42.4	400	1818	1829
26 Aug. 1989	1404	32.5	400	1829	1839

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26 Aug. 1989	1405	37.5	400	1839	1849
26 Aug. 1989	1406	28.3	400	1849	1902
26 Aug. 1989	1201	15.2	400	1907	1912
26 Aug. 1989	1202	38.1	400	1912	1922
26 Aug. 1989	1203	33.3	400	1922	1932
26 Aug. 1989	1204	40.4	400	1932	1947
3 Sep. 1989	1105	33.9	400	1343	1353
3 Sep. 1989	1106	24.7	400	1353	1401
3 Sep. 1989	1301	22.3	400	1403	1409
3 Sep. 1989	1302	34.1	400	1409	1420
3 Sep. 1989	1303	42.7	400	1420	1432
3 Sep. 1989	1304	28.0	400	1432	1443
3 Sep. 1989	1305	43.9	400	1443	1454
3 Sep. 1989	1306	28.2	400	1454	1508
3 Sep. 1989	1101	27.7	400	1509	1517
3 Sep. 1989	1102	39.8	400	1517	1527
38C?P. 1989	1103	35.9	400	1527	1536
3 Sep. 1989	1104	37.7	400	1536	1550
3 Sep. 1989	1205	33.4	400	1615	1623
3 Sep. 1989	1206	22.9	400	1623	1631
3 Sep. 1989	1401	20.9	400	1632	1638
3 Sep. 1989	1402	33.8	400	1638	1648
3 Sep. 1989	1403	42.4	400	1648	1702
35ep. 1989	1404	32.5	400	1702	1711
38ep. 1989	1405	37.5	400	1711	1721
3 Sep. 1989	1406	28.3	400	1721	1737
3 Sep. 1989	1201	15.2	400	1741	1746
3 Sep. 1989	1202	38.1	400	1746	1755
3 Sep. 1989	1203	33.3	400	1755	1803
3 Sep. 1989	1204	40.4	400	1803	1818
4 Sep. 1989	1105	33.9	400	1540	1550
4 Sep. 1989	1106	24.7	400	1550	1559
4 Sep. 1989	1301	22.3	400	1600	1607
4 Sep. 1989	1302	22.3	400	1607	1617
4 Sep. 1989	1303	42.7	400	1617	1630
4 Sep. 1989	1304	28.0	400	1630	1640
4 Sep. 1989	1305	43.9	400	1640	1650
4 Sep. 1989	1306	28.2	400	1650	1656
4 Sep. 1989	1101	27.7	400	1657	1703
4 Sep. 1989	1102	39.8	400	1703	1715
4 Sep. 1989	1103	35.9	400	1715	1724
4 Sep. 1989	1104	37.7	400	1724	1740
4 Sep. 1989	1205	33.4	400	1808	1818
4 Sep. 1989	1206	22.9	400	1818	1826
4 Sep. 1989	1401	20.9	400	1827	1834
4 Sep. 1989	1402	33.8	400	1834	1843
4 Sep. 1989	1403	42.4	400	1843	1$56

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4 Sep. 1989	1404	32.5	400	1856	1908
4 Sep. 1989	1405	37.5	400	1908	1917
4 Sep. 1989	1406	28.3	400	1917	1926
4 Sep. 1989	1201	15.2	400	1931	1936
4 Sep. 1989	1202	38.1	400	1936	1947
4 Sep. 1989	1203	33.3	400	1947	1956
4 Sep. 1989	1204	40.4	400	1956	2012
11 Sep. 1989	1105	33.9	400	1431	1443
11 Sep. 1989	1106	24.7	400	1443	1451
11 Sep. 1989	1301	22.3	400	1452	1458
11 Sep. 1989	1302	34.1	400	1458	1507
11 Sep. 1989	1303	42.7	400	1507	1520
11 Sep. 1989	1304	28.0	400	1520	1532
11 Sep. 1989	1305	43.9	400	1532	1543
11 Sep. 1989	1306	28.2	400	1543	1556
11 Sep. 1989	1101	27.7	400	1558	1608
11 Sep. 1989	1102	39.8	400	1608	1622
11 Sep. 1989	1103	35.9	400	1622	1635
11 Sep. 1989	1104	37.7	400	1635	1651
11 Sep. 1989	1205	33.4	200	1716	1725
11 Sep. 1989	1206	22.9	200	1725	1734
11 Sep. 1989	1401	20.9	200	1735	1741
11 Sep. 1989	1402	33.8	200	1741	1752
11 Sep. 1989	1403	42.4	200	1752	1806
11 Sep. 1989	1404	32.5	200	1806	1818
11 Sep. 1989	1405	37.5	200	1818	1828
11 Sep. 1989	1406	28.3	200	1828	1840
11 Sep. 1989	1201	15.2	200	1844	1850
11 Sep. 1989	1202	38.1	200	1850	1901
11 Sep. 1989	1203	33.3	200	1901	1911
11 Sep. 1989	1204	40.4	200	1911	1922
27 Jul. 1990	1105	33.9	400	1247	1258
27 Jul. 1990	1106	24.7	400	1258	1306
27 Jul. 1990	1401	20.9	400	1307	1315
27 Jul. 1990	1402	33.8	400	1315	1326
27 Jul. 1990	1403	42.4	400	1326	1341
27 Jul. 1990	1404	32.5	400	1341	1352
27 Jul. 1990	1405	37.5	400	1352	1404
27 Jul. 1990	1406	28.3	400	1404	1414
27 Jul. 1990	1101	27.7	400	1415	1424
27 Jul. 1990	1102	39.8	400	1424	1436
27 Jul. 1990	1103	35.9	400	1436	1445
27 Jul. 1990	1104	37.7	400	1445	1457
27 Jul. 1990	1205	33.4	400	1524	1533
27 Jul. 1990	1206	22.9	400	1533	1540
27 Jul. 1990	1301	22.3	400	1541	1549
27 Jul. 1990	1302	34.1	400	1549	1600

27 Jul. 1990	1303	42.7	400	1600	1616
27 Jul. 1990	1304	28.0	400	1616	1628
27 Jul. 1990	1305	43.9	400	1628	1640
27 Jul. 1990	1306	28.2	400	1640	1651
27 Jul. 1990	1201	15.2	400	1655	1659
27 Jul. 1990	1202	38.1	400	1659	1710
27 Jul. 1990	1203	33.3	400	1710	1719
27 Jul. 1990	1204	40.4	400	1719	1731
28 Jul. 1990	1105	33.9	400	1313	1324
28 Jul. 1990	1106	24.7	400	1324	1331
28 Jul. 1990	1301	22.3	400	1333	1341
28 Jul. 1990	1302	34.1	400	1341	1353
28 Jul. 1990	1303	42.7	400	1353	1408
28 Jul. 1990	1304	28.0	400	1408	1421
28 Jul. 1990	1305	43.9	400	1421	1434
28 Jul. 1990	1306	28.2	400	1434	1444
28 Jul. 1990	1101	27.7	400	1445	1453
28 Jul. 1990	1102	39.8	400	1556	1608
28 Jul. 1990	1103	35.9	400	1608	1618
28 Jul. 1990	1104	37.7	400	1618	1628
11 Aug. 1990	1105	33.9	400	1704	1715
11 Aug. 1990	1106	24.7	400	1715	1723
11 Aug. 1990	1301	22.3	400	1724	1732
11 Aug. 1990	1302	34.1	400	1732	1744
11 Aug. 1990	1303	42.7	400	1744	1759
11 Aug. 1990	1304	28.0	400	1759	1811
11 Aug. 1990	1305	43.9	400	1811	1824
11 Aug. 1990	1306	28.2	400	1824	1833
11 Aug. 1990	1101	27.7	400	1835	1843
11 Aug. 1990	1102	39.8	400	1843	1855
11 Aug. 1990	1103	35.9	400	1855	1906
11 Aug. 1990	1104	37.7	400	1906	1917
12 Aug. 1990	1205	33.4	400	1332	1342
12 Aug. 1990	1206	22.9	400	1342	1349
12 Aug. 1990	1401	20.9	400	1350	1357
12 Aug. 1990	1402	33.8	400	1357	1408
12 Aug. 1990	1403	42.4	400	1408	1421
12 Aug. 1990	1404	32.5	400	1421	1432
12 Aug. 1990	1405	37.5	400	1432	1444
12 Aug. 1990	1406	28.3	400	1444	1454
12 Aug. 1990	1201	15.2	400	1458	1502
12 Aug. 1990	1202	38.1	400	1502	1513
12 Aug. 1990	1203	33.3	400	1513	1523
12 Aug. 1990	1204	40.4	400	1523	1535
12 Aug. 1990	1105	33.9	400	1606	1617
12 Aug. 1990	1106	24.7	400	1617	1625

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12 Aug. 1990	1301	22.3	400	1626	1633
12 Aug. 1990	1302	34.1	400	1633	1645
12 Aug. 1990	1343	42.7	400	1645	1700
12 Aug. 1990	1304	28.0	400	1700	1712
12 Aug. 1990	1305	43.9	400	1712	1725
12 Aug. 1990	1306	28.2	400	1725	1736
12 Aug. 1990	1101	27.7	400	1737	1745
12 Aug. 1990	1102	39.8	400	1745	1757
12 Aug. 1990	1103	35.9	400	1757	1807
12 Aug. 1990	1104	37.7	400	1807	1818
22 Aug. 1990	1205	33.4	400	1123	1133
22 Aug. 1990	1206	22.9	400	1133	1140
22 Aug. 1990	1401	20.9	400	1141	1148
22 Aug. 1990	1402	33.8	400	1148	1159
22 Aug. 1990	1403	42.4	400	1159	1213
22 Aug. 1990	1404	32.5	400	1213	1224
22 Aug. 1990	1405	37.5	400	1224	1237
22 Aug. 1990	1406	28.3	400	1237	1246
22 Aug. 1990	1201	15.2	400	1250	1255
22 Aug. 1990	1202	38.1	400	1255	1305
22 Aug. 1990	1203	33.3	400	1305	1314
22 Aug. 1990	1204	40.4	400	1314	1326
22 Aug. 1990	1105	33.9	400	1353	1404
22 Aug. 1990	1106	24.7	400	1404	1412
22 Aug. 1990	1301	22.3	400	1414	1421
22 Aug. 1990	1302	34.1	400	1421	1432
22 Aug. 1990	1303	42.7	400	1432	1447
22 Aug. 1990	1304	28.0	400	1447	1459
22 Aug. 1990	1305	43.9	400	1459	1512
22 Aug. 1990	1306	28.2	400	1512	1523
22 Aug. 1990	1101	27.7	400	1524	1532
22 Aug. 1990	1102	39.8	400	1532	1543
22 Aug. 1990	1103	35.9	400	1543	1553
22 Aug. 1990	1104	37.7	400	1553	1604
23 Aug. 1990	1205	33.4	400	1254	1304
23 Aug. 1990	1206	22.9	400	1304	1311
23 Aug. 1990	1401	20.9	400	1313	1319
23 Aug. 1990	1402	33.8	400	1319	1330
23 Aug. 1990	1403	42.4	400	1330	1343
23 Aug. 1990	1404	32.5	400	1343	1353
23 Aug. 1990	1405	37.5	400	1353	1407
23 Aug. 1990	1406	28.3	400	1407	1416
23 Aug. 1990	1201	15.2	400	1421	1425
23 Aug. 1990	1202	38.1	400	1425	1435
23 Aug. 1990	1203	33,3	400	1435	1444
23 Aug. 1990	1204	40.4	400	1444	1458
23 Aug. 1990	1105	33.9	400	1614	1626

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23 Aug. 1990	1106	24.7	400	1626	1635
23 Aug. 1990	1301	22.3	400	1636	1642
23 Aug. 1990	1302	34.1	400	1642	1651
23 Aug. 1990	1303	42.7	400	1651	1703
23 Aug. 1990	1304	28.0	400	1703	1712
23 Aug. 1990	1305	43.9	400	1712	1725
23 Aug. 1990	1306	28.2	400	1725	1734
23 Aug. 1990	1101	27.7	400	1735	1744
23 Aug. 1990	1102	39.8	400	1744	1757
23 Aug. 1990	1103	35.9	400	1757	1810
23 Aug. 1990	1104	37.7	400	1810	1823
8 Sep. 1990	1205	33.4	400	1210	1219
8 Sep. 1990	1206	22.9	400	1219	1226
8 Sep. 1990	1401	20,9	400	1228	1235
8 Sep. 1990	1402	33.8	400	1235	1247
8 Sep. 1990	1403	42.4	400	1247	1301
8 Sep. 1990	1404	32.5	400	1301	1311
8 Sep. 1990	1405	37.5	400	1311	1322
8 Sep. 1990	1406	28.3	400	1322	1331
8 Sep. 1990	1201	15.2	400	1336	1341
8 Sep. 1990	1202	38.1	400	1341	1354
8 Sep. 1990	1203	28.0	400	1357	1405
8 Sep. 1990	1204	40.4	400	1405	1417
8 Sep. 1990	1105	33.9	400	1446	1456
8 Sep. 1990	1106	24.7	400	1456	1504
8 Sep. 1990	1301	22.3	400	1506	1513
8 Sep. 1990	1302	34.1	400	1513	1524
8 Sep. 1990	1303	42.7	400	1524	1538
8 Sep. 1990	1304	28.0	400	1538	1548
8 Sep. 1990	1305	43.9	400	1548	1559
8 Sep. 1990	1306	28.2	400	1559	1607
8 Sep. 1990	1101	27.7	400	1608	1617
8 Sep. 1990	1102	39.8	400	1617	1631
8 Sep. 1990	1103	35.9	400	1631	1642
8 Sep. 1990	1104	37.7	400	1642	1653
10 Sep. 1990	1205	33.4	400	1059	1110
105ep. 1990	1206	22.9	400	1110	1118
10 Sep. 1990	1401	20.9	400	1119	1125
10 Sep. 1990	1402	33.8	400	1125	1134
10 Sep. 1990	1403	42.4	400	1134	1146
105ep. 1990	1404	32.5	400	1146	1156
10 Sep. 1990	1405	37.5	400	1156	1206
10 Sep. 1990	1406	28.3	400	1206	1214
10 Sep. 1990	1201	15.2	400	1220	1225
10 Sep. 1990	1202	38.1	400	1225	1238
105ep, 1990	1203	33.3	400	1238	1249
10 Sep. 1990	1204	40.4	400	1249	1303

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105ep. 1990	1105	33.9	400	1338	1350
10 Sep. 1990	1106	24.7	400	1350	1359
10 **Sep.** 1990	1301	22.3	400	1401	1407
10 sep. 1990	1302	34.1	400	1407	1416
105ep. 1990	1303	42.7	400	1416	1428
10 Sep. 1990	1304	28.0	400	1428	1438
105ep. 1990	**1305**	43.9	400	1438	1449
105ep. 1990	1306	28.2	400	1449	1456
105ep. 1990	1101	27.7	400	1458	1508
105ep. 1990	1102	39.8	400	1508	1522
10 Sep. 1990	1103	35.9	400	1522	1535
10 Sep. 1990	1104	37.7	400	1535	1548

Appendix A-2. Average Densities of the 5 Key Bird Species On Aerial Survey Transects in the Kasegaluk Lagoon area, Chukchi Sea, Alaska, 1989 and 1990.

Appendix A-2-1. Linear densities (birds / km) of brant recorded during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, 1989.

Transect	Survey Date in 1989					Mean	Standard
Number	24 Aug	26 Aug	3 Sep	4 Sep	11 Sep		Deviation
1101	**108.21**	193.75	114.90	30.35	10.22	91.49	7353
1102	**947.27**	833.34	159.20	41.57	15.82	399.44	470.32
1103	**1.89**	0.00	0.00	3.22	0.38	1.10	648.57
1104	**0.00**	0.00	0.00	0.00	0.49	0.00	
1105	**0.00**	1.24	0.00	1.93	0.00	0.63	0.81
1106	**0.26**	0.00	0.00	0.00	0.53	0.16	
1201	**123.53**	202.61	190.59	75.88	0.00	118.52	653.98
1202	**394.85**	70.37	27.31	21.03	4.88	103.69	687.26
1203	**0.00**	0.00	0.90	0.63	0.00	0.31	0.38
1204	**0.00**	0.00	0.00	2.90	0.00	0.00	
1205	**0.00**	0.00	0.00	0.00	0.71	0.00	
1206	**0.00**	0.00	0.00	1.15	1.91	0.61	.
1301	**2.75**	2.80	0.21	5.89	14.70	5.27	696.99
1302	**1.65**	1.21	0.49	4.04	2.39	1.96	697.02
1303	**11.57**	1.50	0.58	5.05	7.15	5.17	697.04
1304	**4.31**	0.14	0.00	1.52	2.44	1 .6a	697.06
1305	**0.10**	24.86	8.71	35.20	7.32	15.24	697.21
1306	**17.28**	37.81	23.32	3.64	2.01	16.81	697.58
1401	**0.00**	1.45	1.45	4.83	3.86	2.32	697.84
1402	**0.00**	0.00	0.00	8.99	0.73	1.94	
1403	**0.00**	0.00	0.12	2.92	0.68	0.74	697.86
1404	**0.00**	0.00	0.00	0.03	0.00	0.00	.
1405	**0.00**	34.30	3.43	29.26	0.37	13.47	698.06
1406	**0.00**	39.13	2.83	7.97	1.88	10.36	**698.41**

Appendix A-2-2. Linear densities (birds/km) of brant recorded during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, 1990.

Transect Number	Survey Date in 1990 27 Jul	28 Jul	11 Aug	12 Aug	22 Aug	23 Aug	8 Sep	10 Sep	Mean	Standard Deviation
1101	0.00	0.00	5.74	0.00	1.12	5.87	5.32	15.13	4.15	5.19
1102	0.91	6.82	202.68	203.57	31.09	149.77	170.09	124.41	111.17	86.05
1103	0.00	0.00	8.36	4.58	9.77	21.74	8.66	17.58	8.84	146.93
1104	O.(KI	0,00	0.00	0.00	2.15	7.38	0,00	0.00	1.19	
1105	0.00	0.37	0.00	1,36	4.08	19.41	1.01	0.00	3.28	147.41
1106	0.00	0.00	15.04	0.30	3.95	3.27	0.00	0.00	2.82	147.55
1201	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.64	0.00	
1202	0.00	0.00	0.00	54.88	1.08	9.42	2.37	34.43	17.03	176.41
1203	0.00	0.00	0.00	0.00	0.75	0.00	205.18	0.60	34.42	196.13
1204	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	
1205	0.00	0.00	0.00	0.00	0.00	1.57	0.00	0.00	0.00	·
1206	0.00	0.00	0.00	0.00	14.59	3.06	0.00	0.00	2.94	
1301	0.00	0.00	0.42	2.33	18.52	7.75	0.00	1.27	3.79	169.02
1302	0.00	0.00	0.00	1.76	23.60	4.40	0.00	0.00	3.72	169.26
1303	0.09	0.00	2.34	2.85	6.66	0.86	1.52	0.00	1.79	169.33
1304	23.45	26.70	0.86	0.00	0.55	0.00	2.33	22.99	9.61	169.78
1305	9.27	1.89	21.39	8.32	5.85	3.46	106.98	28.79	23.24	173.67
1306	0,00	1.59	1.77	0.00	4.84	0.11	10.95	18.27	4.69	175.57
1401	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00	·
1402	0.00	0.00	0.00	0,00	5.28	2.39	0.00	0.00	1.28	
1403	0.00	0.00	0.00	0.00	1.87	7.24	0.00	0.00	1.52	
1404	0.77	0.00	0.00	22.45	1.61	6.19	2.07	6.47	6.59	208.02
1405	0.00	0.00	0.00	25.59	46.52	4.01	182.43	44.06	50.44	218.82
1406	0.00	0.00	0.00	0.00	138	0.00	10.87	15.51	4.63	225.79

Appendix A-2-3. Areal densities (birds/sq km) of oldsquaw recorded during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989

Transect Number	Survey Date in 1989 24 Aug	26 Aug	3 Sep	4 Sep	11 Sep	Mean	Standard Deviation
1101	0.00	0.00	0.00	0.00	0.40	0.00	
1102	5,68	0.00	0.00	0.00	9.72	3.08	4.46
1103	0,00	0.00	0.00	0.00	0.00	0.00	
1104	0.00	0.00	0.00	0.00	19.43	0.00	
1105	0,00	0.00	0.00	0.00	0.12	0.02	11.23
1106	0.00	0.00	0.00	0.00	23.31	4.66	15.32
1201	20.75	3.43	42.48	28.59	22.22	23.49	21.48
1202	0.92	0.26	3.63	2.64	48.15	11.12	39.?7
1203	3.00	0.83	0.00	5.71	0.00	1.91	41.74
1204	0.00	0.00	2.83	2.90	0.00	1.15	41.83
1205	0.00	0.14	0.21	0.14	0.00	0.10	41.85
1206	0.00	2.99	0.60	6.94	0.00	2.11	41.95
1301	0.00	0.21	0.11	0.00	21.19	4.30	43.06
1302	0.00	1.37	0.00	218	1.99	1.11	43.34
1303	0.00	59.87	26.58	30.43	0.76	23.53	49.93
1304	1.44	5.75	15.09	20.33	1.36	8.79	57.07
1305	4.72	0.33	5.51	14.96	9.45	6.99	58.18
1306	18.90	4.42	38.69	101.50	39.75	40.65	69.42
1401	0,00	0.12	0.00	3.62	0.00	0.75	82.99
1402	0.00	0.00	0.28	0.00	0.00	0.06	82.99
1403	0.00	0.00	0.00	0.00	0.00	0.00	
1404	0.00	0.00	0.00	0.00	0.00	0.00	
1405	0.07	0.00	0.66	0.00	0.00	0.15	82.99
1406	0.00	0.00	0.00	9.06	0.00	1.81	83.09

Appendix A-2-4. Areal densities (birds/sq km) of oldsquaw recorded during aerial surveys of **Kasegaluk** Lagoon, **Chukchi Sea, Alaska, in 1990.**

Transect Number	27 Jul	28 Jul	11 Aug	12 Aug	22 Aug	23 Aug	8 Sep	10 Sep	Mean	Standard Deviation
	Survey Date in 1990									
1101	2.00	0.00	0.00	0.00	0.00	2.40	0.00	0.00	0.55	1.02
1102	0.00	0.00	0.00	57.61	0.00	0.28	1.14	0.00	7.38	20.33
1103	0.00	0.00	0.00	0.00	0.00	0.00	0.06	1.45	0.19	
1104	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,00	0.00	
1105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
1106	9.87	0.00	0.00	0.19	0.00	0.00	0.00	0.00	1.26	22.09
1201	1.14	0.00	0.00	0.16	19.12	133.17	10.78	15.20	29.93	57.45
1202	0.33	0.00	0.00	7.39	7.65	56.07	6.13	4.88	13.74	69.37
1203	4.05	0.(KI	0.00	0.00	5.63	1.28	0.00	2.03	2.17	71.02
1204	0.00	0.00	0.00	0.00	0.19	0.00	0.25	2,64	0.51	71.07
1205	0.36	0.00	0.00	1.71	0.00	0.14	0.29	0.57	0.51	71.08
1206	0.00	0.00	0.00	0.24	2.75	3.35	0.00	0.48	1.14	71.09
1301	0.00	0.00	1.06	0.21	0.00	4.77	0.53	0.85	0.93	60.12
1302	2.06	0.00	0.69	3.64	0.00	1.24	2.06	0.76	1.31	60.14
1303	9.52	4.61	26.23	20.09	4.50	8.00	5.84	3.21	10.25	60.73
1304	38.58	21.98	20.26	61.14	56.75	107.33	3.09	2.23	38.92	71.13
1305	5.25	21.92	73.16	55.64	32.55	86.61	6.23	2.56	35.49	88.66
1306	129.51	56.98	161.66	107.42	77.92	258.30	15.90	7.33	101.88	126.97
1401	0.72	0.00	0.00	0.00	0.48	0.72	0.12	0.60	0.44	197.93
1402	0.14	0.00	0.00	12.36	2.46	1.62	0.07	0.00	2.78	197.99
1403	0.88	0.00	0.00	0.88	1.75	1.29	0.23	0.00	0.84	198.02
1404	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
1405	0.00	0.00	0.00	15.63	1.25	2.37	0.53	1.85	3.61	198.11
1406	0.27	0.00	0.00	0.00	1.90	0.82	1.27	0.18	0.74	198.15

Appendix A-2-5. Areal densities (birds/sq km) of glaucous gulls recorded during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989.

Transect	Survey Date in 1989					Mean	Standard
Number	24 Aug	26 Aug	3&p	4 Sep	11 Sep		Deviation
1101	0.16	0.00	0.00	0.00	0.64	0.16	0.28
1102	0.11	0.17	0.40	0.68	0.40	0.35	0.40
1103	0.50	0.31	0.13	0.31	0.44	0.34	0.58
1104	0.06	0.39	0.00	0.13	0.32	0.18	0.71
1105	0.00	0.31	0.25	0.19	1.49	0.45	0.95
1106	0.00	1.41	0.00	0.47	1.03	0.58	1.24
1201	0.16	0.00	0.16	0.00	0.00	0.06	1.41
1202	0.66	0.07	0.33	1.12	1.45	0.73	1.52
1203	0.23	0.23	0.00	0.00	0.30	0.15	1.73
1204	0.00	0.19	0.00	0.06	0.00	0.05	-
1205	0.00	0.07	0.07	0.07	0.14	0.07	1.74
1206	0.84	0.72	0.00	0.12	0.00	0.34	1.79
1301	0.74	0.64	3.81	0.24	1.06	1.30	2.32
1302	0.48	0.76	2.06	0.21	1.30	0.96	2.84
1303	1.81	1.05	2.45	1.40	2.39	1.82	3.09
1304	0.86	3.45	4.09	2.30	0.50	2.24	4.02
1305	4.92	0.92	4.13	2.36	2.03	2.87	5.01
1306	1.77	1.06	2.30	0.18	0.97	1.26	6.00
1401	0.00	0.12	0.12	0.36	2.17	0.55	6.23
1402	0.00	0.00	0.00	0.28	0.70	0.20	6.27
1403	0.12	0.88	0.29	0.76	0.23	0.46	6.28
1404	0.00	0.00	0.15	0.31	1.24	0.34	6.33
1405	0.00	0.00	0.00	0.13	2.11	0.45	6.41
1406	0.18	0.00	0.18	0.00	0.18	0.11	6.43

Appendix A-2-6. Areal densities (birds/sq km) of glaucous gulls recorded during areial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1990.

Transect	Survey Date in 1990								Mean	Standard
Number	27 Jul	28 Jul	11 Aug	12 Aug	22 Aug	23 Aug	8 Sep	10 Sep		Deviation
1101	0.96	0.08	1.04	1.68	0.48	0.56	0.72	1.52	0.88	0.54
1102	0.80	1.65	0.57	0.57	1.70	0.63	0.40	1.14	0.93	1.20
1103	0.38	0,31	0.13	0.06	0.76	0.31	0.63	0.38	0.37	1.57
1104	0.06	0.45	0.26	0,39	1.94	4.02	4.08	0.52	1.47	2.35
1105	1.18	0.06	0.50	0.74	0.80	0.68	0.80	1.42	0.77	2.85
1106	0.09	0.00	9.02	0.75	0.56	1.41	0.85	0.85	1.69	4.22
1201	1.47	0.00	0.00	0.00	0.65	0.00	0.00	0.33	0.41	5.46
1202	0.33	0.00	0,00	0.26	0.13	0.26	0.00	0.13	0.19	5.48
1203	0.08	0.00	0.00	0.23	0.38	0.00	0.00	0.00	0.12	5.49
1204	0.00	0.00	0.00	0.19	0.00	0.00	0.06	0.00	0.04	5.49
1205	38.14	0.00	0.00	0.14	0.29	0.00	0.07	0.00	6.44	16.47
1206	1.32	0.00	0.00	0.24	0.48	0.72	0.00	2.27	0.84	17.94
1301	4.66	8.90	2.54	0.64	1.69	0.42	0.21	2.01	2.63	15.46
1302	69.99	4.88	3.23	1.03	0.82	0.27	1.37	0.00	10.20	28.87
1303	47.49	7.71	11.16	6.37	5.08	2.28	0.29	0.41	10.10	34.56
1304	4.09	13.72	3.52	0.65	2.73	0.93	0.14	0.36	3.27	36.48
1305	1.25	0.39	0.72	0.79	0.39	2.36	1.51	3.74	1.39	36.67
1306	1.24	2.47	1.77	1.86	0.53	0.09	3.98	0.44	1.55	36.72
1401	3.99	0.00	0.00	2.42	0.72	0.12	4.35	19.69	5.22	44.10
1402	5.34	0.00	0.00	1.33	1.54	1.05	6.32	3.72	3.22	44.52
1403	8.76	0.00	0.00	1.75	1.81	1.69	6.25	18.46	6.45	45.14
1404	3.64	0.00	0.00	3.41	1.70	0.77	2.24	1.93	2.28	45.71
1405	1.39	0.00	0.00	1.98	2.24	1.78	10.75	13.19	5.22	46.08
1406	2.72	0.00	0.00	1.00	2.90	0.72	4.53	9.33	3.53	46.54

Appendix A-2-7. **Areal densities (birds/sq km) of arctic terns recorded during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, 1989.**

Transect Number	Survey Date in 1989 24 Aug	26 Aug	3 Sep	4 Sep	11 Sep	Mean	Standard Deviation
1101	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1102	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1103	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1104	0.00	0.00	0.00	0.00	0.00	0.00	
1105	0.00	0.00	0.00	0.00	0.00	0.00	-
1106	0.00	0.00	0.00	0.00	0.00	0.00	
1201	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1202	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1203	0.00	0.00	0.00	0.00	0.00	0.00	
1204	0.00	0.00	0.00	0.00	0.00	0.00	
1205	0.00	0.00	0.00	0.00	0.00	0.00	
1206	0.00	0.12	0.00	0.00	0.00	0.00	
1301	0.00	0.42	0.00	0.00	0.00	0.00	0.00
1302	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13Q3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1304	0.07	0.00	0.07	0.00	0.00	0.03	0.00
1305	0.00	0.20	0.00	0.00	0.00	0.00	0.00
1306	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1401	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1402	0.00	0.00	0.00	0.00	0.00	0.00	
1403	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1404	0.08	0.00	0.00	0.00	0.00	0.02	
1405	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1406	0.00	0.00	0.00	0.00	0,00	0.00	0.00

Appendix A-2-8. Areal densities (birds/sq km) of arctic terns recorded during aerial surveys of Kasegaluk *Lagoon*, **Chukchi Sea, Alaska, 1990.**

Transect	Survey Date in 1990								Mean	Standard
Number	27 Jul	28 Jul	11 Aug	12 Aug	22 Aug	23 Aug	8 Sep	10 Sep		Deviation
1101	0.00	0.00	0.16	0.08	0.00	0.00	0.00	0.00	0.03	
1102	0.91	0.11	0.63	0.28	0.11	0.17	0.06	0.00	0.28	0.33
1103	0.00	0.06	0.00	0.06	0.00	0.00	0,00	0.00	0.02	
1104	0.00	0.00	0.13	0.00	0,00	0.00	0,00	0.00	0.02	
1105	0.12	0.19	0.00	0.12	0.00	0.43	0.00	0.00	0.11	0.47
1106	0.09	1.69	0,47	0.09	0.00	0,47	0,00	0.00	0.35	0.76
1201	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.
1202	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.
1203	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
1204	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
1205	0.21	0.OO	0.00	0.21	0.21	1.36	0.00	0.00	0.33	1.13
1206	0.60	0.00	0.00	0.24	1.91	0.72	0.00	0.00	0.58	1.39
1301	2.54	1.59	8.37	4.24	6.99	7.73	0.00	0.00	3.93	3.66
1302	1.92	7.14	25.48	58.17	7.90	0.14	0.00	0.00	12.59	21.04
1303	12.8s	9.93	16.00	44.16	11.27	0.12	0.00	0.00	11.79	28.91
1304	0.65	1.58	19.61	28.45	16.59	0.00	0.07	0.93	8.48	33.51
1305	13.78	17.39	10.30	5.71	42.85	18.04	0.98	0.00	13.63	37.31
1306	0.35	2.65	0.27	2.83	0.00	0.00	0.00	0.00	0.76	40.07
1401	0.36	0,00	0.00	0.12	0.12	0.36	0.00	0.00	0.16	47.43
1402	1.05	0.00	0.00	3.16	1.26	0.07	0.00	0.00	0.92	47,44
1403	0.12	0.00	0.00	0.99	0.18	2.10	0.00	0.00	0.56	47.46
1404	0.39	0.00	0.00	4.18	22.68	1.78	0.00	0.00	4.84	48.29
1405	2.90	0.00	0.00	29.02	53.43	1.72	0.00	0.00	14.51	53.37
1406	0.45	0.00	0.00	4.35	0.00	0.00	0.00	0.00	0.80	

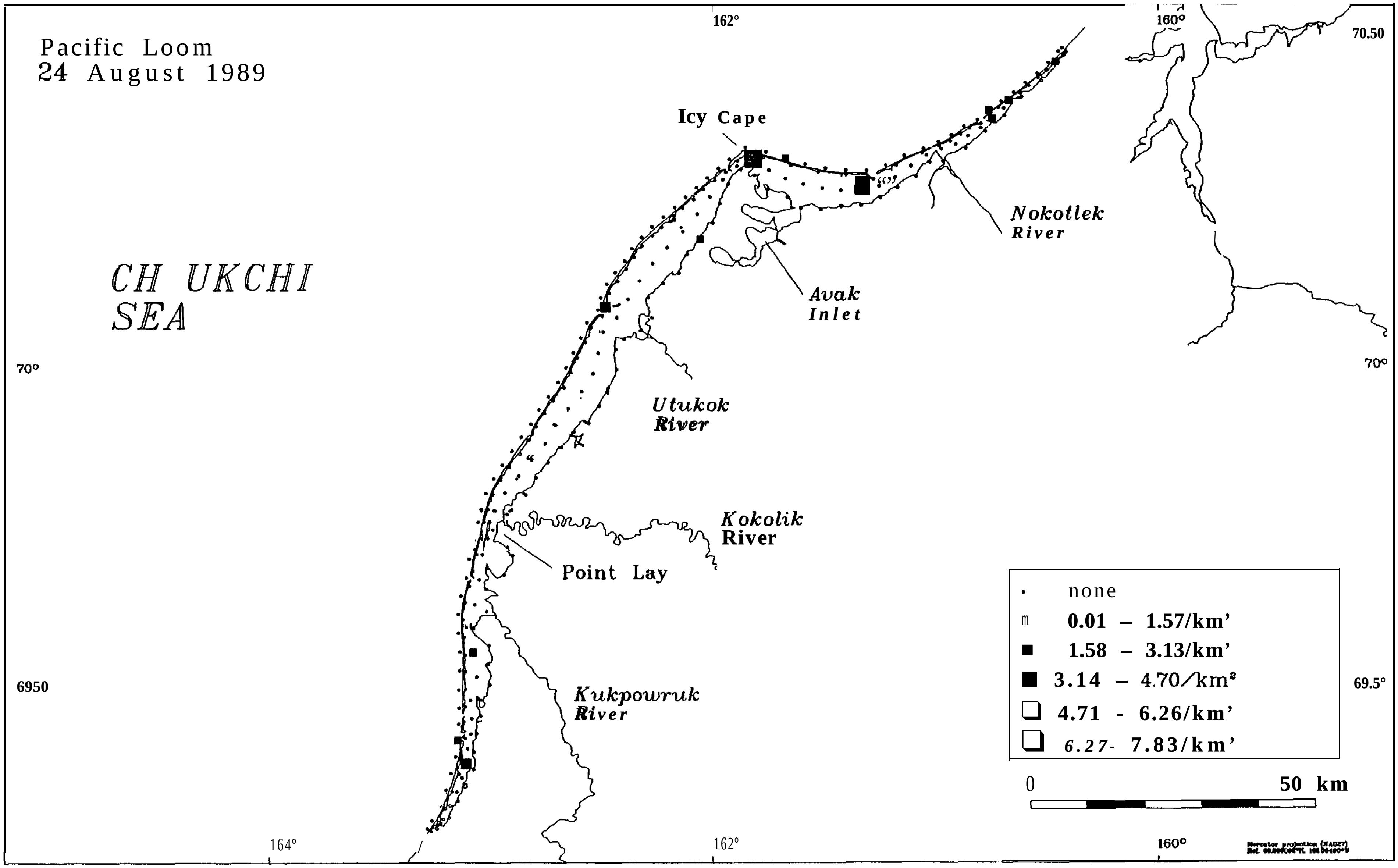
Appendix A-2-9. Areal densities (birds/sq km) of small shorebirds recorded during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1989.

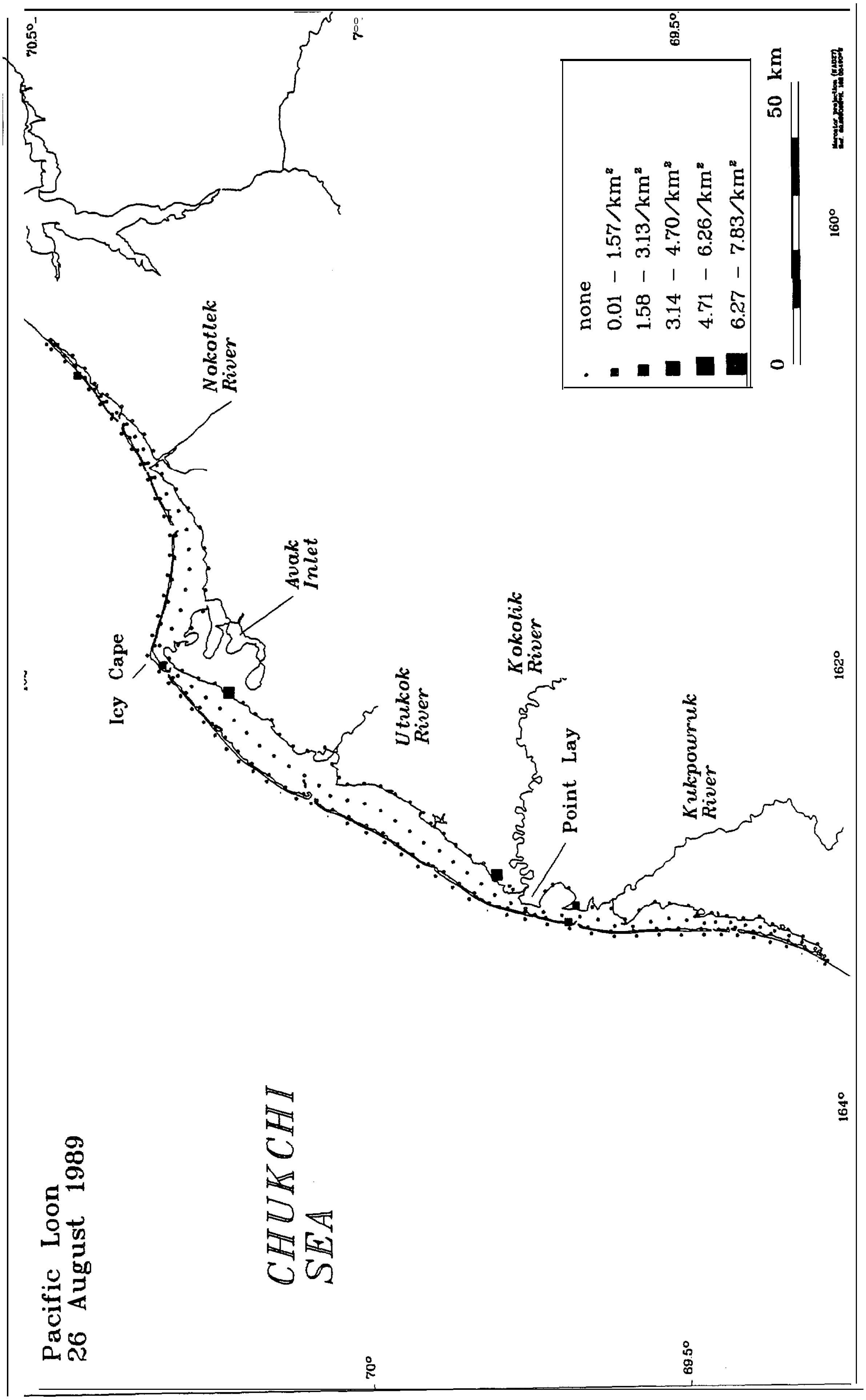
Transect	Survey Date in 1989					Mean	Standard
Number	24 Aug	24 Aug	3sep	4sep	11 Sep		Deviation
1101	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1102	0.11	2.50	0.00	0.06	0.00	0.53	1.10
1103	0.00	0.82	0.00	0.63	0.50	0.39	0.37
1104	0.00	19.43	0.00	0.00	0.00	3.89	8.69
1105	0.00	2.41	0.00	0.00	0.12	0.51	1.07
1106	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1201	12.25	0.00	0.00	0.00	0.00	2.45	5.48
1202	3.30	0.00	0.00	0.66	9.89	2.77	4.21
1203	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1204	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1205	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1206	2.99	22.73	47.85	0.00	0.00	14.71	20.81
1301	21.19	224.79	41.31	7.94	1.59	59.36	93.72
1302	0.00	2.75	0.34	0.00	5.50	1.72	2.41
1303	0.06	1.75	30.72	0.00	3.15	7.14	13.25
1304	0.07	12,14	10.42	0.00	0.29	4.58	6.14
1305	0.00	20.08	0.33	1.64	6.76	5.76	8.45
1306	0.18	0.00	8.83	0.00	0.00	1.80	3.93
1401	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1402	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1403	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1404	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1405	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1406	0.00	0.00	0.00	0.00	0.00	0.00	0.00

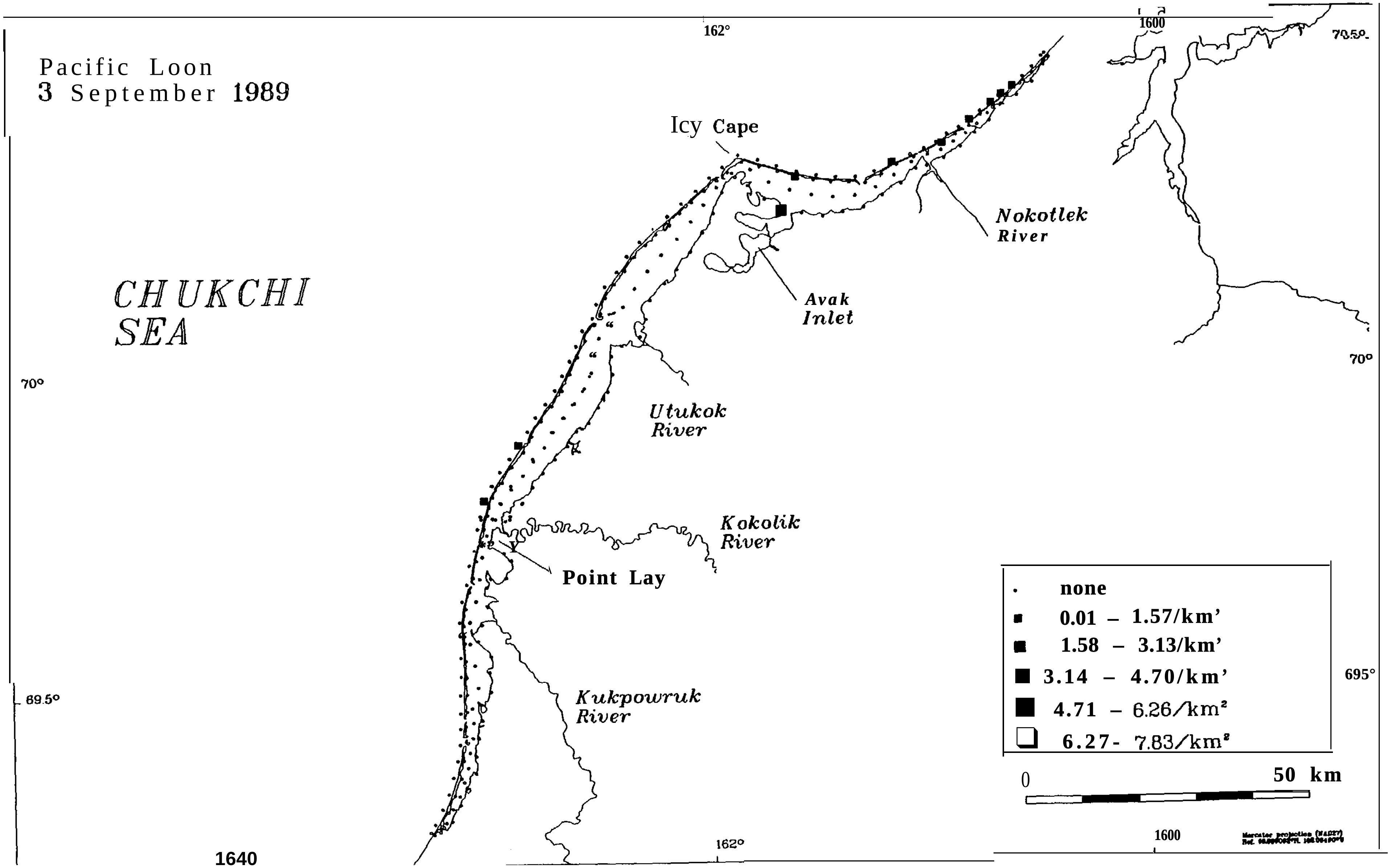
Appendix A-2-IO. Areal densities (birds/sq km) of small shorebirds recorded during aerial surveys of Kasegaluk Lagoon, Chukchi Sea, Alaska, in 1990.

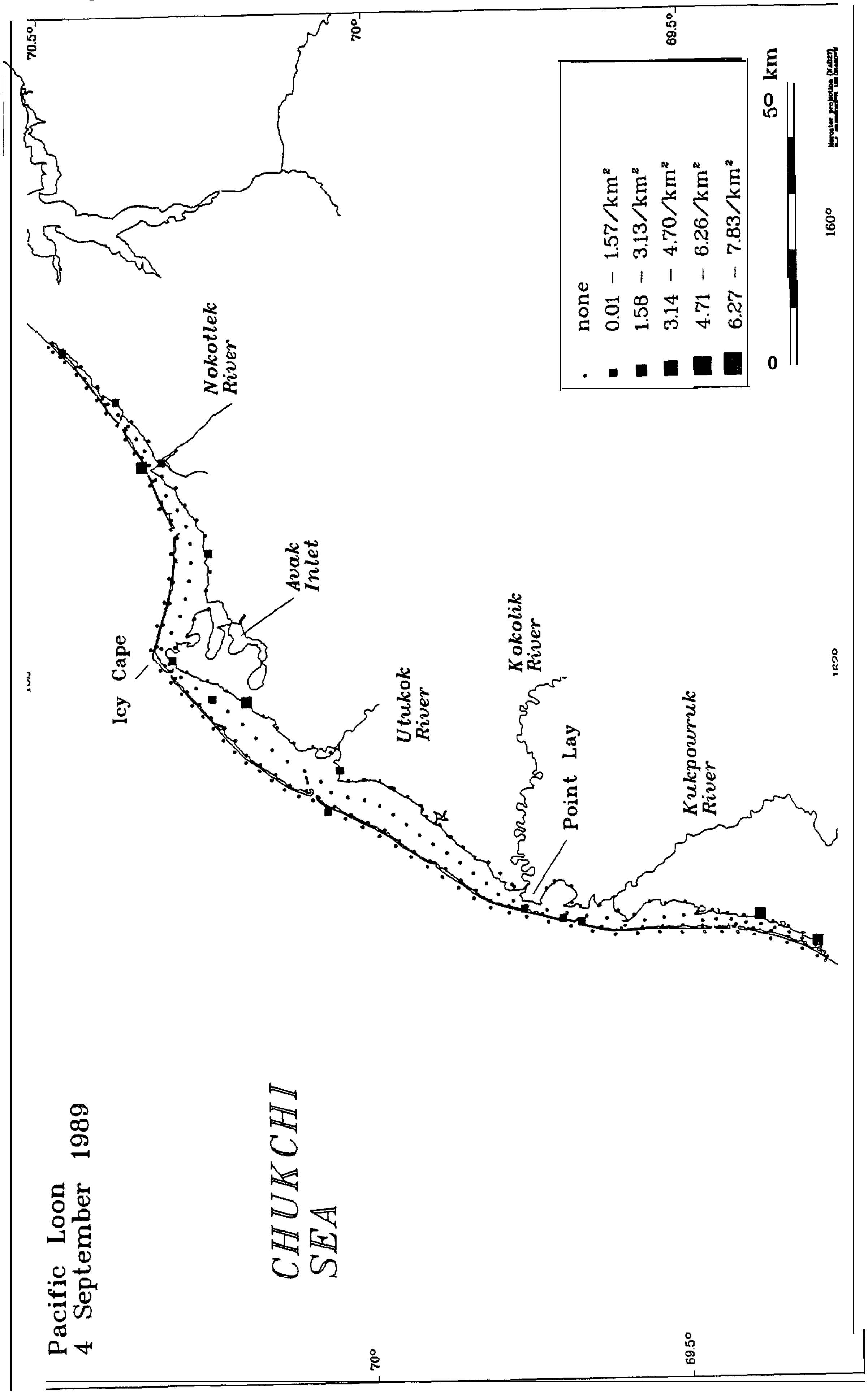
Transect	Survey Date in 1990								Mean	Standard
Number	27 Jul	28 Jul	11 Aug	12 Aug	22 Aug	23 Aug	8 Sep	10 Sep		Deviation
1101	1.28	3.61	1.68	0.40	0.00	1.20	0.00	0.00	1.02	1.24
1102	2.84	0.97	2.33	2.27	2.84	5.11	1.59	1.42	2.42	1.28
1103	6.23	0.50	37.09	1.32	0.31	0.00	0.00	0.00	5.68	12.86
1104	10.43	2.00	17.16	3.24	0.00	29.15	0.00	0.00	7.75	10.61
1105	3.47	4.51	15.16	36.38	2.85	0.00	0.68	0.00	7.88	12.52
1106	1.88	31.11	7.42	5.17	1.41	6.67	5.83	0.09	7.45	9.93
1201	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1202	32.72	0.00	0.00	0.00	13.19	22.10	0.00	0.00	8.50	12.84
1203	0.00	0.00	0.00	0.00	O.(XI	0.00	0.00	0.00	0.00	0.00
1204	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1205	0.00	0.00	0.00	2.86	0.00	1.36	0.00	0.00	0.53	1.06
1206	120.22	0.00	0.00	5.62	357.06	8.37	0.00	144.14	79.43	126.69
1301	283.16	131.25	346.09	113.88	68.11	698.62	0.21	90.04	216.42	225.60
1302	4.19	23.83	5.57	4.39	6.52	0.00	0.00	4.12	6.08	7.56
1303	4.03	19.86	4.73	2.7.5	23.83	4.38	0.00	0.00	7.45	9.13
1304	0.00	7.18	0.07	0.00	0.00	0.00	0.00	0.00	0.91	2.54
1305	0.66	0.26	17.72	0.46	0.20	0.00	0.00	3.28	2.82	6.12
1306	1.77	11.66	34.01	9.45	14.58	5.30	0.00	0.00	9.60	11.27
1401	0.12	0.00	0.00	0.00	0.00	0,00	0.60	0.00	0.09	0.21
1402	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.04	0.12
1403	0.00	0.00	0.00	35.87	0.18	9.35	0.00	0.00	5.68	12.63
1404	0.00	0.00	0.00	0.39	0.31	0.00	0.00	0.00	0.09	0.16
1405	0.00	0.00	0.00	34.70	0.00	0.00	0.00	0.00	4.34	12.27
1406	0.00	0.00	0.00	146.56	0.00	0.00	0.00	0.00	18.32	51.82

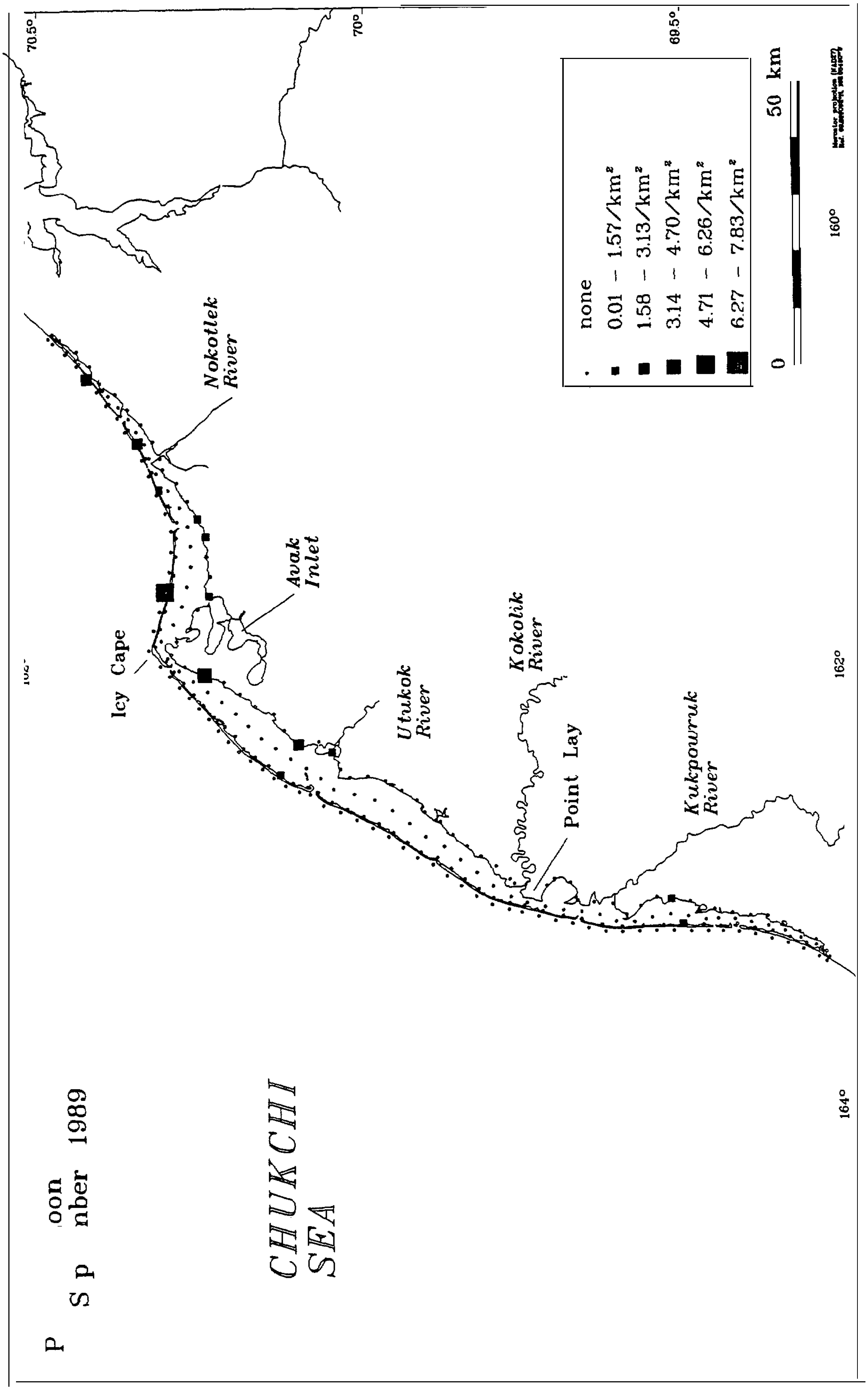
Appendix B. Daily Density Maps of Birds and Mammals, **Kasegaluk** Lagoon, Chukchi Sea, Alaska, 1989-1990.


Pacific Loom
24 August 1989
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.50
70°
6950
69.5°
164°
none
0.01 – 1.57/km'
1.58 – 3.13/km'
3.14 – 4.70/km²
4.71 - 6.26/km'
6.27- 7.83/km'
0
50 km

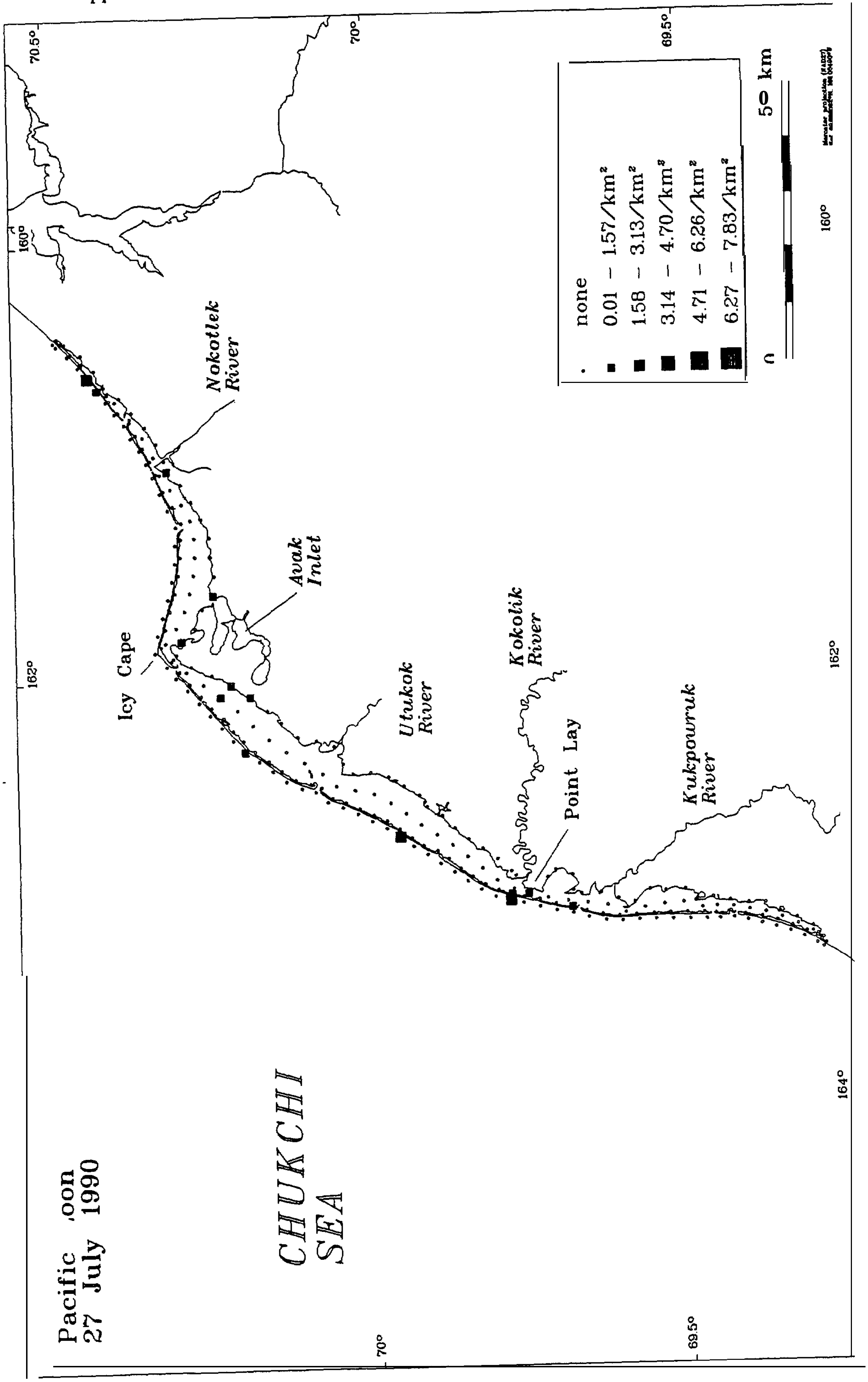

Pacific Loon
26 August 1989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 1.57/km²
1.58 - 3.13/km²
3.14 - 4.70/km²
4.71 - 6.26/km²
6.27 - 7.83/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

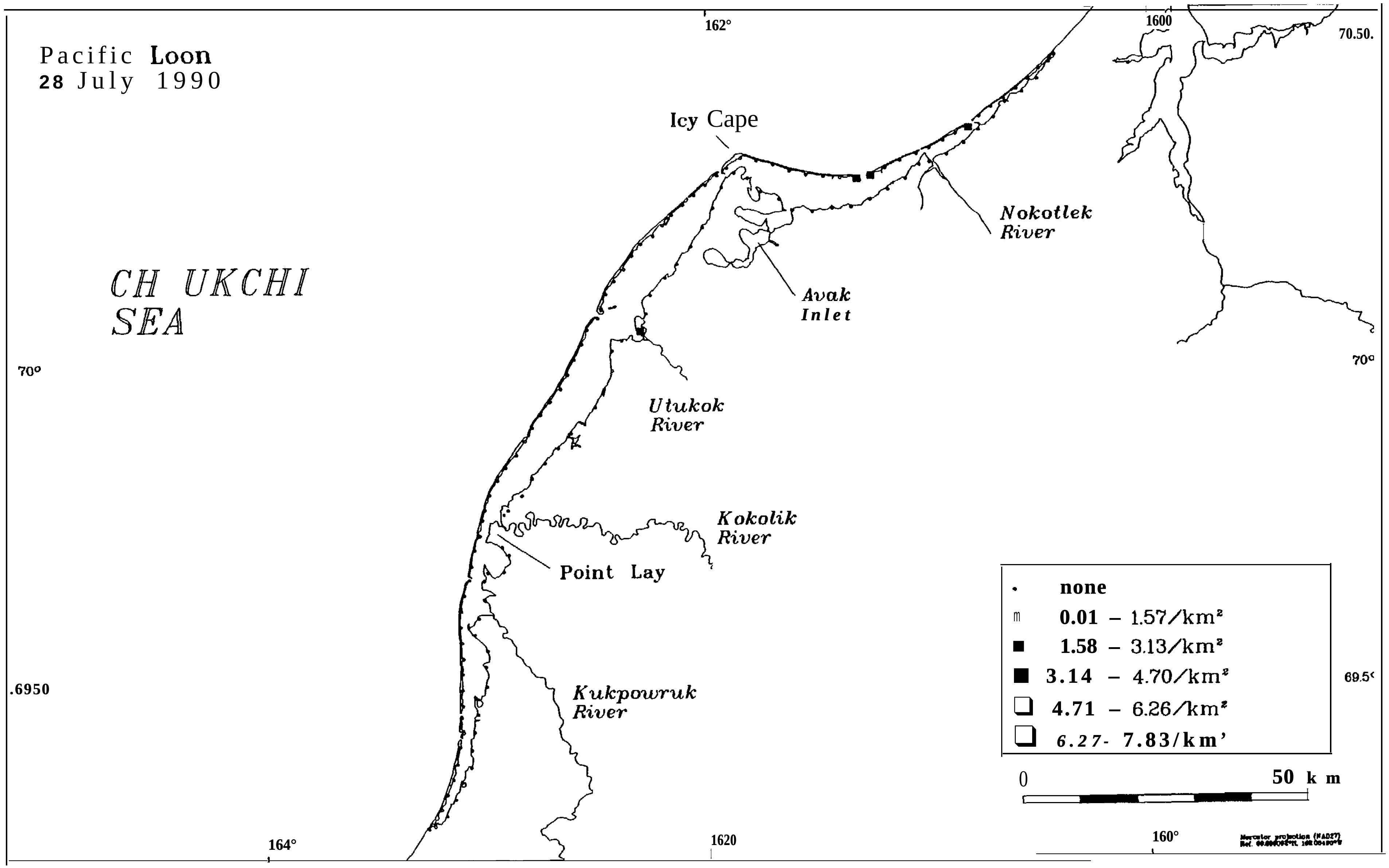

Pacific Loon
3 September 1989
Icy Cape
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 1.57/km'
1.58 – 3.13/km'
3.14 – 4.70/km'
4.71 – 6.26/km²
6.27- 7.83/km²
0
50 km
162°
1600
70.5°
70°
69.5°
695°
1640
162°
1600


Pacific Loon
4 September 1989
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 1.57/km²
1.58 – 3.13/km²
3.14 – 4.70/km²
4.71 – 6.26/km²
6.27 – 7.83/km²
0
50 km
70.5°
70°
69.5°
160°

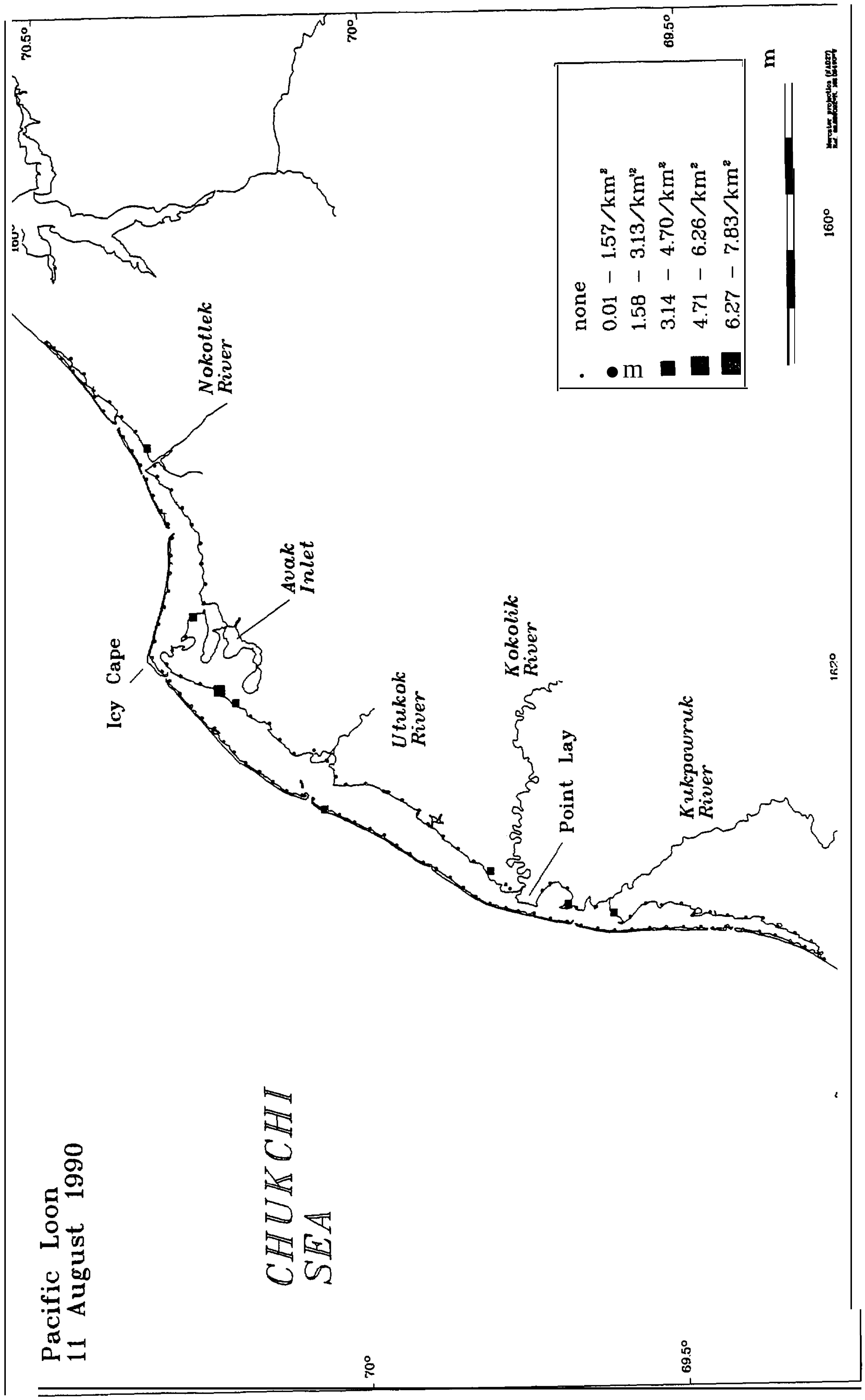


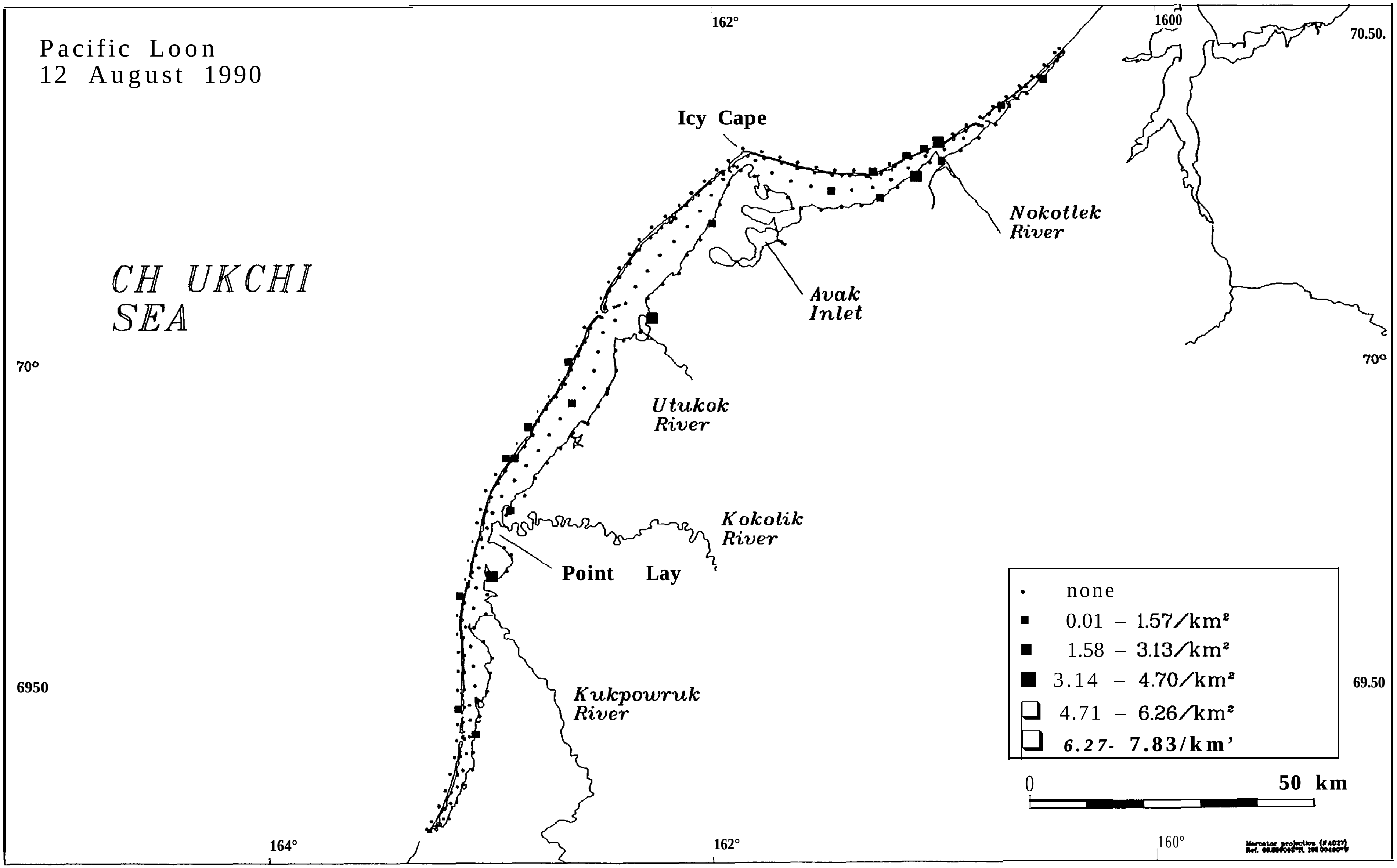
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 1.57/km²
1.58 - 3.13/km²
3.14 - 4.70/km²
4.71 - 6.26/km²
6.27 - 7.83/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

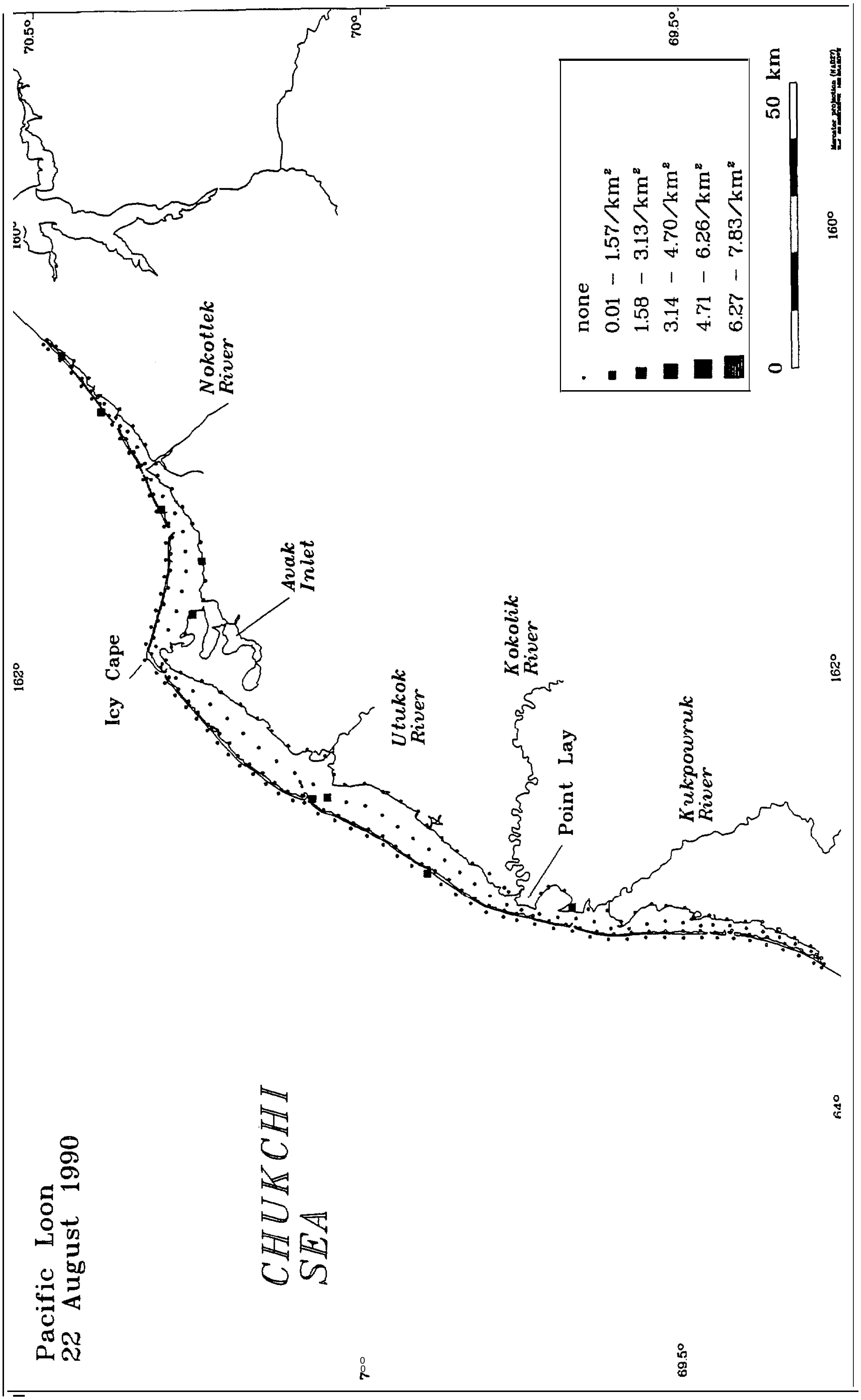

Pacific .oon
27 July 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 1.57/km²
1.58 – 3.13/km²
3.14 – 4.70/km²
4.71 – 6.26/km²
6.27 – 7.83/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

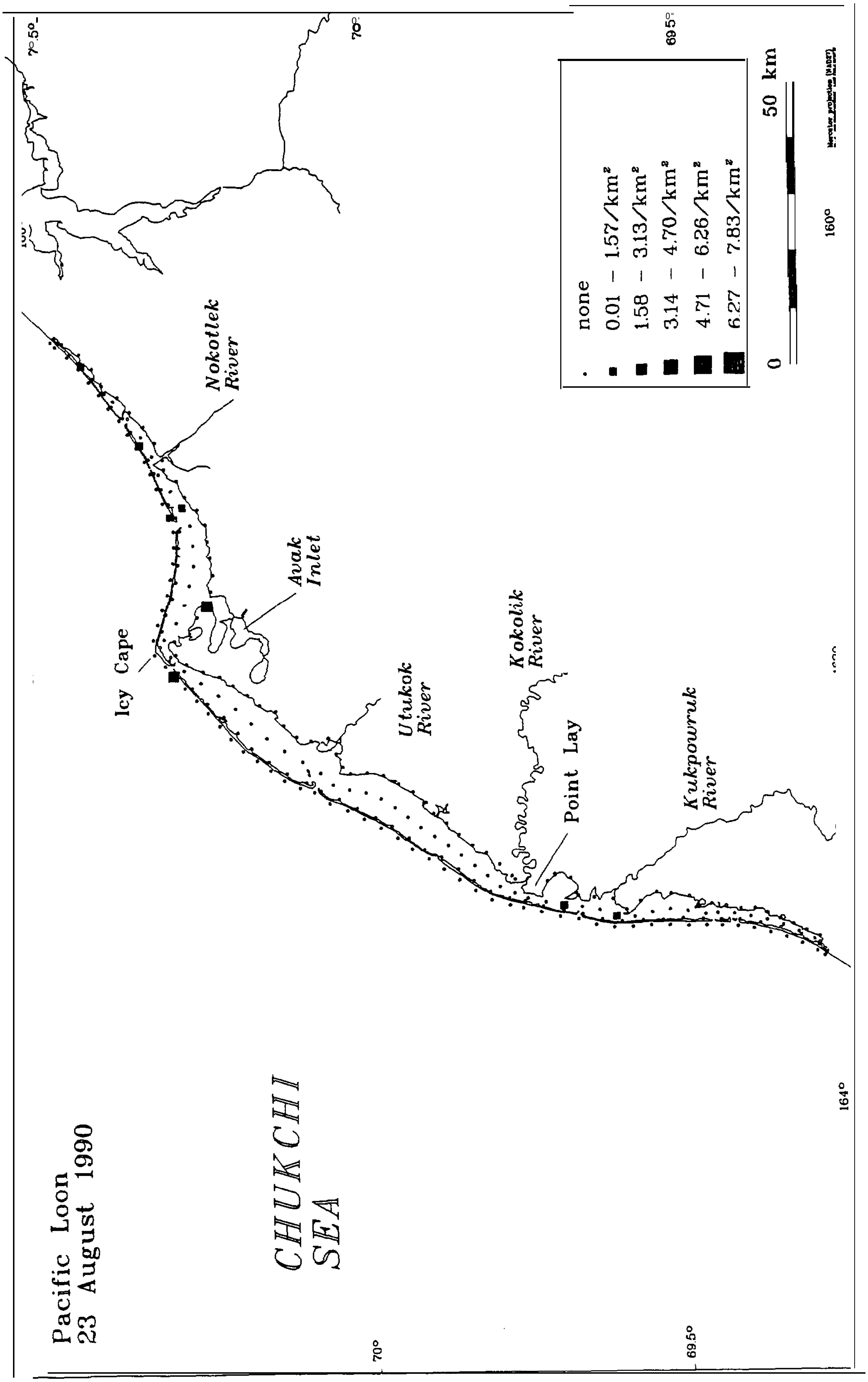


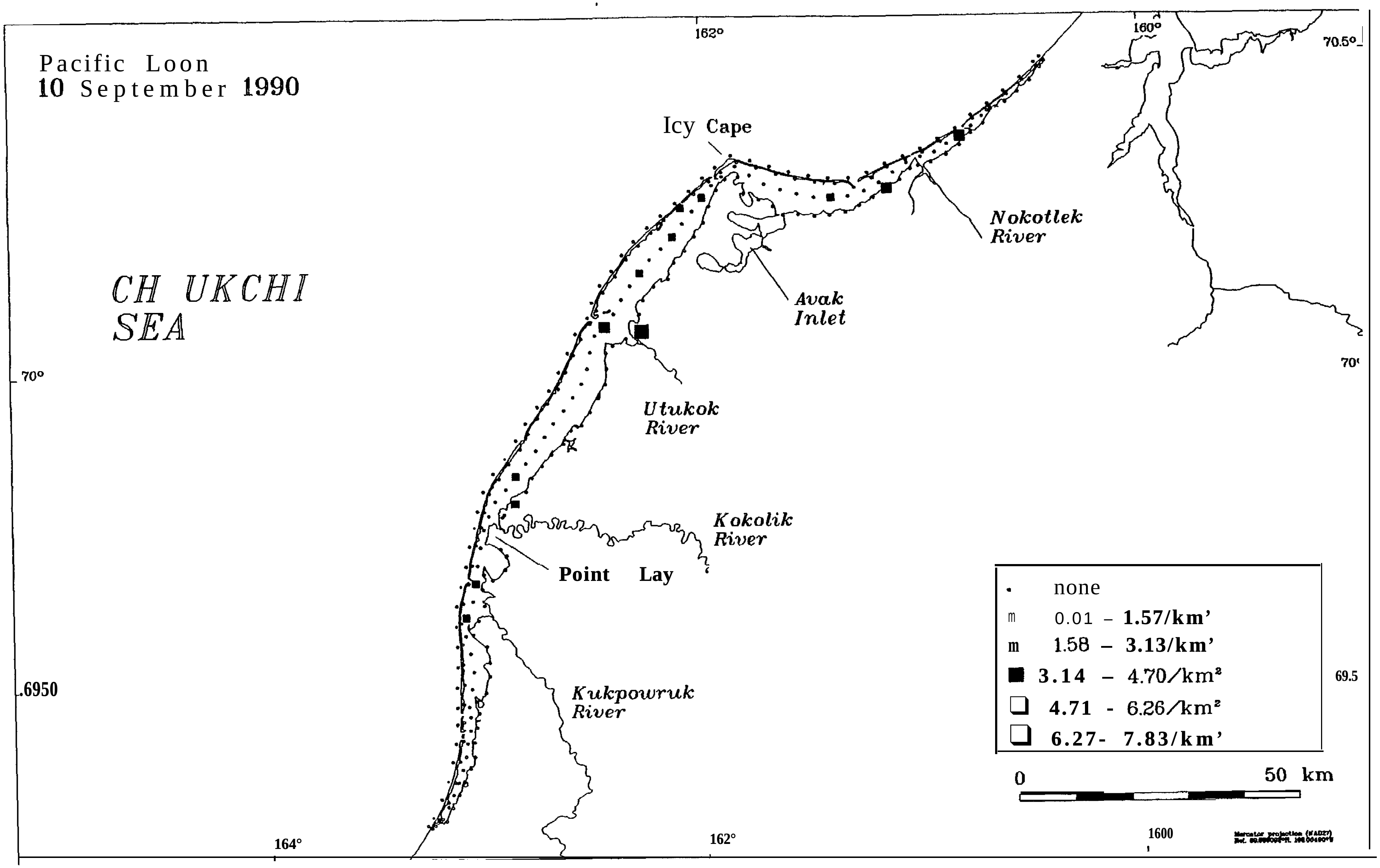
Pacific Loon
28 July 1990
Icy Cape
CH UKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
1600
70.50.
70°
70°
.6950
69.5°
164°
1620
160°
none
0.01 – 1.57/km²
1.58 – 3.13/km²
3.14 – 4.70/km²
4.71 – 6.26/km²
6.27- 7.83/km'
0
50 km

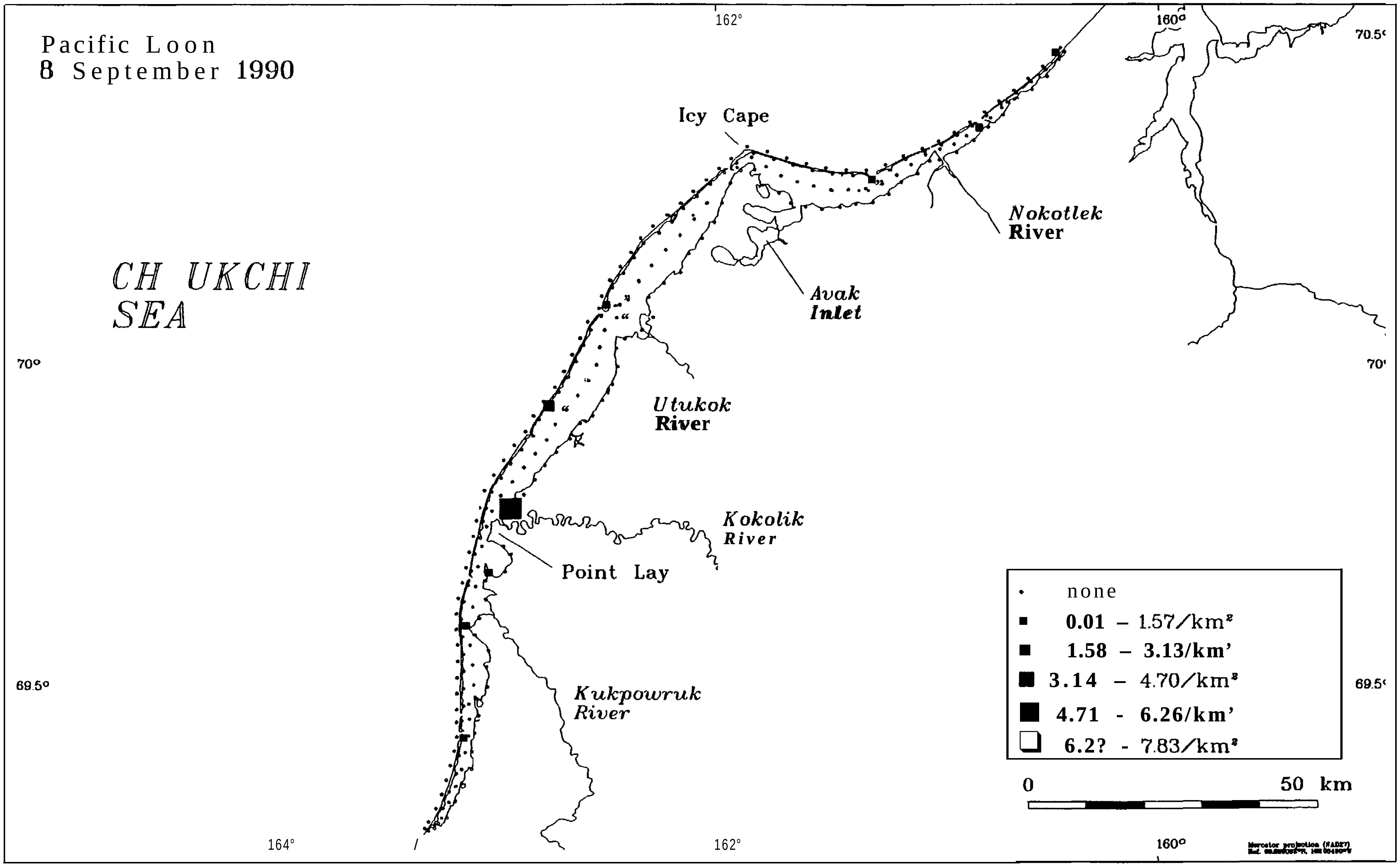

Pacific Loon
11 August 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 1.57/km²
1.58 – 3.13/km²
3.14 – 4.70/km²
4.71 – 6.26/km²
6.27 – 7.83/km²
70.5°
70°
69.5°
160°
162°

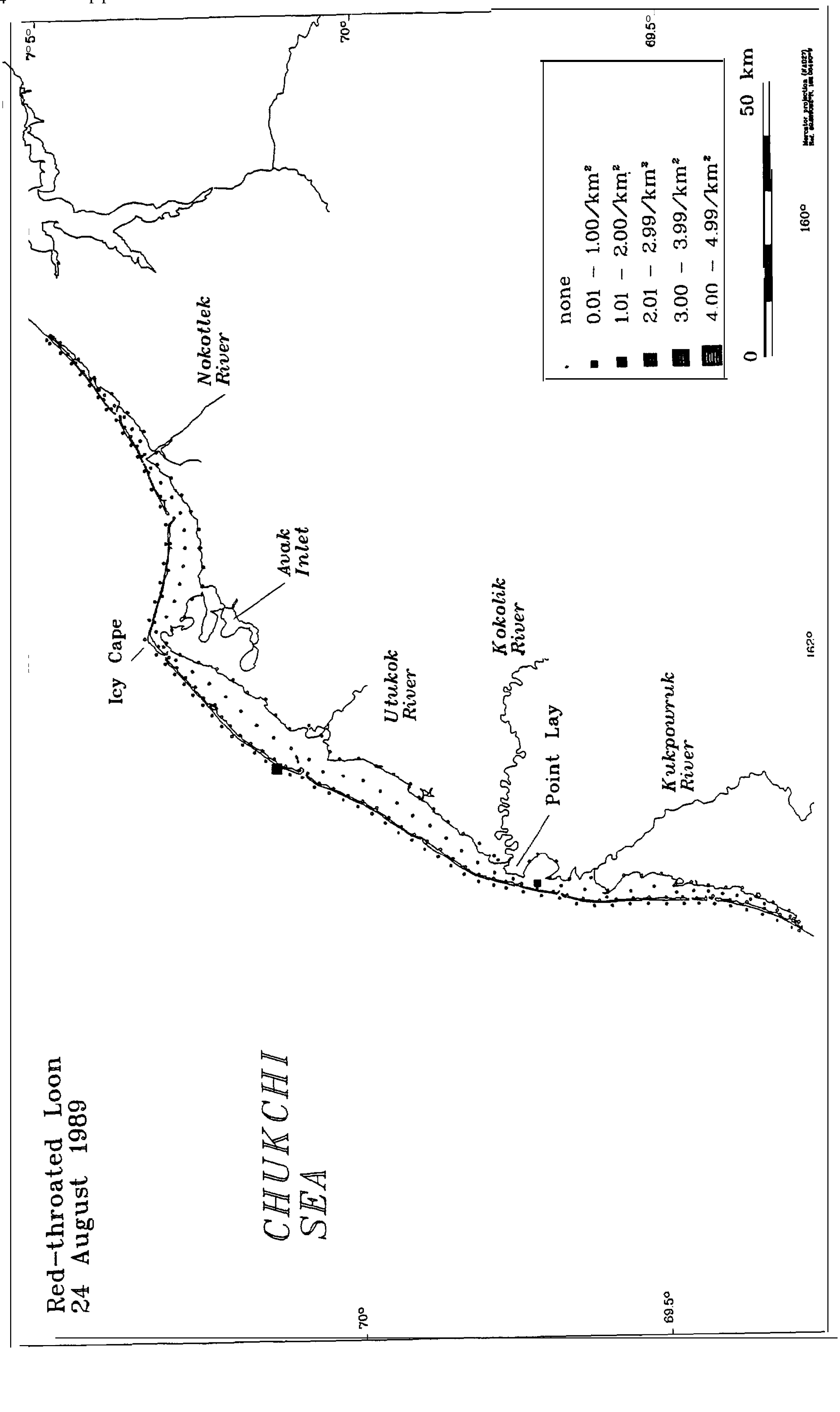

Pacific Loon
12 August 1990
Icy Cape
CH UKCHI
SEA
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
1600
70.50.
70°
70°
6950
69.50
164°
162°
160°
none
0.01 – 1.57/km²
1.58 – 3.13/km²
3.14 – 4.70/km²
4.71 – 6.26/km²
6.27- 7.83/km'
0
50 km

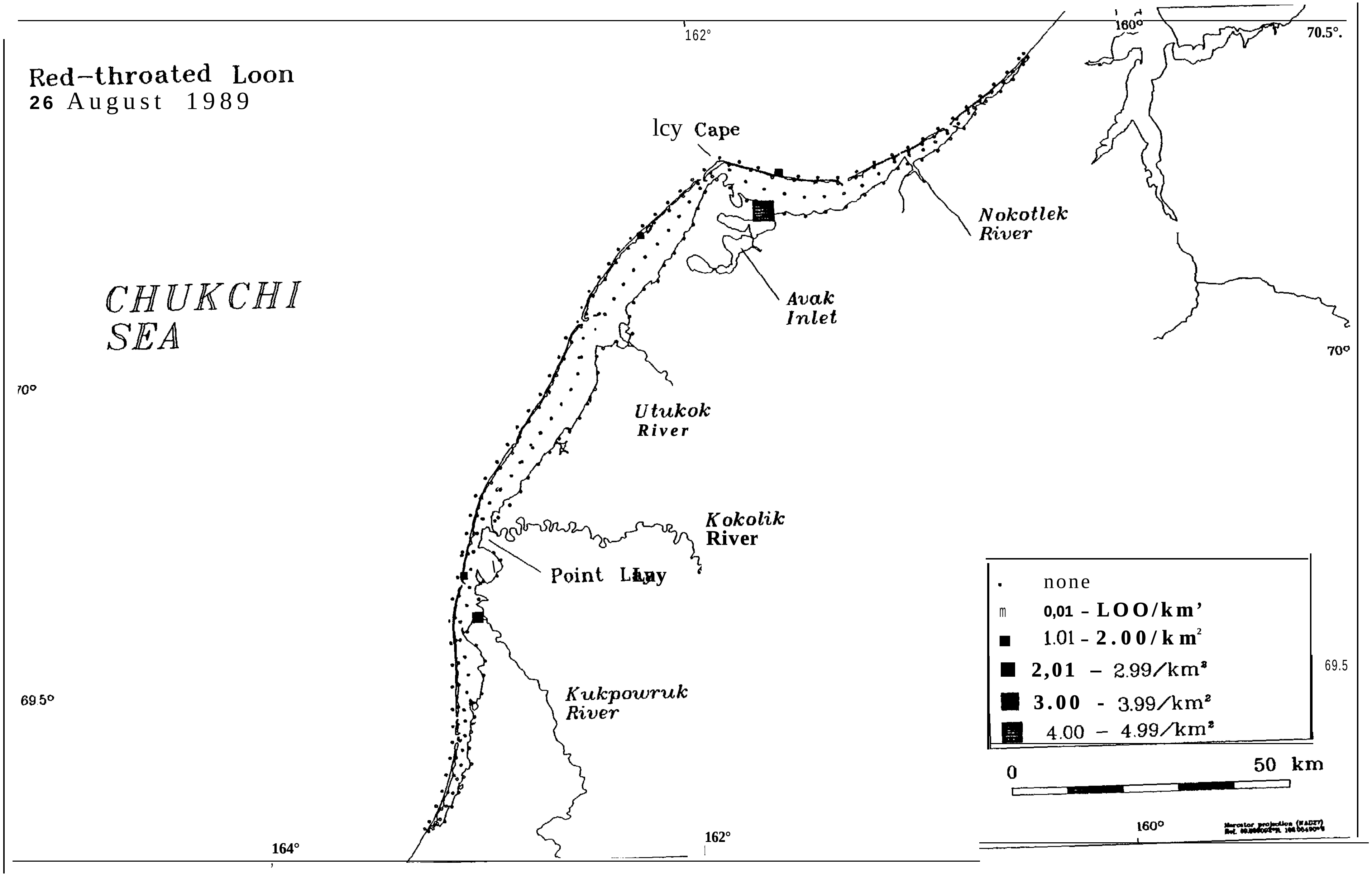

Pacific Loon
22 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 1.57/km²
1.58 – 3.13/km²
3.14 – 4.70/km²
4.71 – 6.26/km²
6.27 – 7.83/km²
0
50 km
70.5°
70°
69.5°
162°
160°
164°

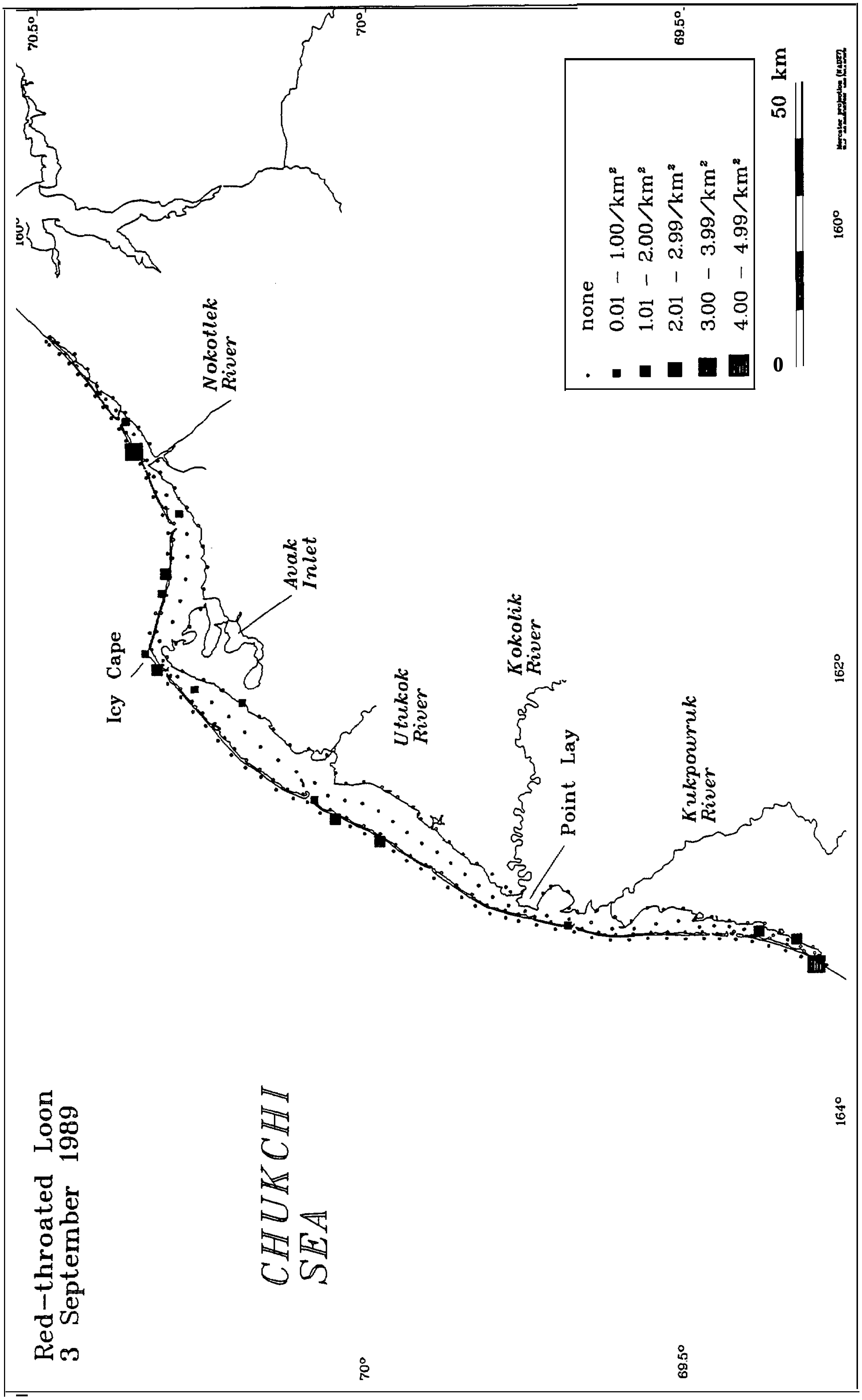

Pacific Loon
23 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 1.57/km²
1.58 – 3.13/km²
3.14 – 4.70/km²
4.71 – 6.26/km²
6.27 – 7.83/km²
0
50 km
70°
69.5°
164°
160°

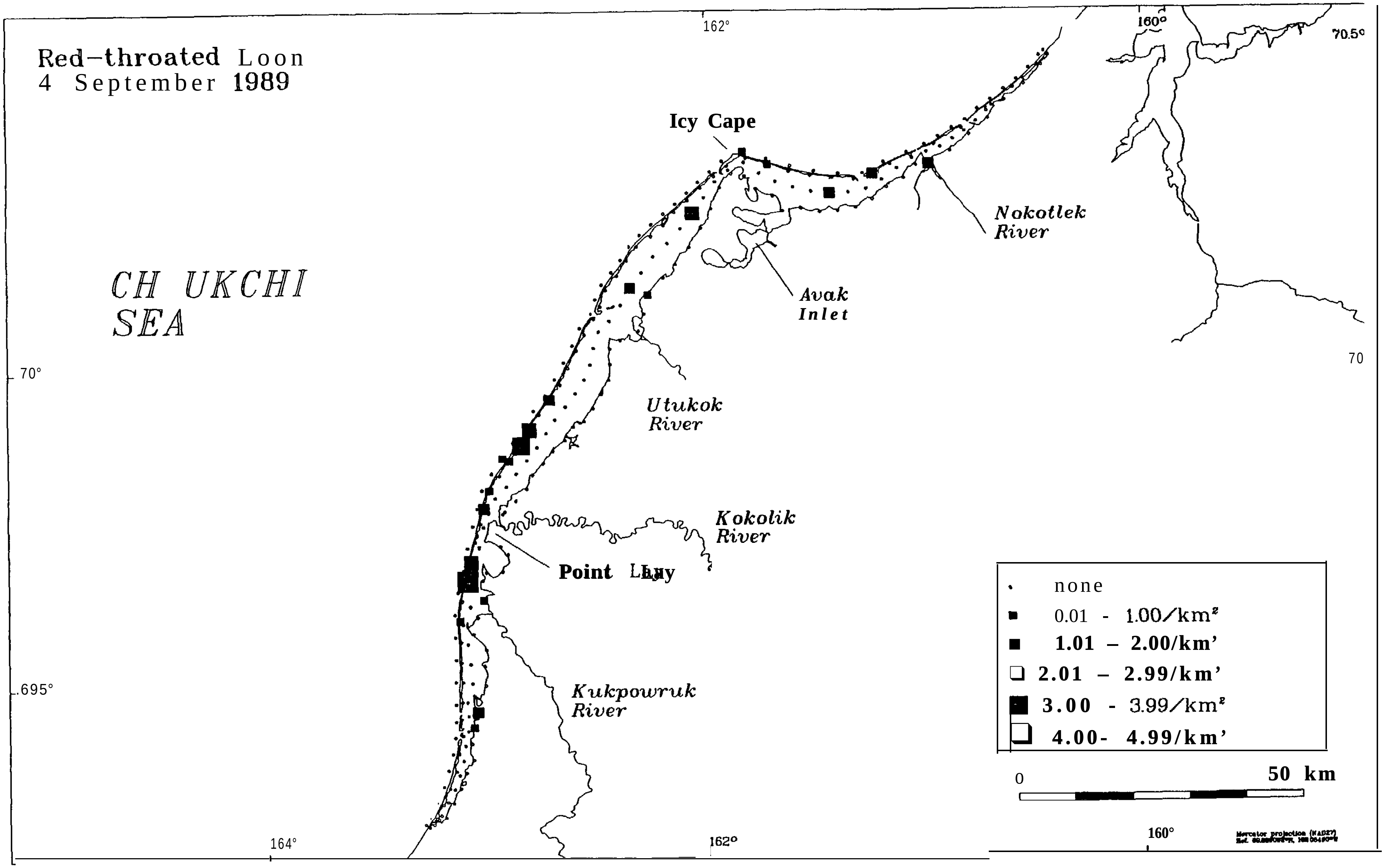

Pacific Loon
10 September 1990
Icy Cape
CH UKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
.6950
69.5
164°
1600
none
0.01 – 1.57/km'
1.58 – 3.13/km'
3.14 – 4.70/km²
4.71 - 6.26/km²
6.27- 7.83/km'
0
50 km

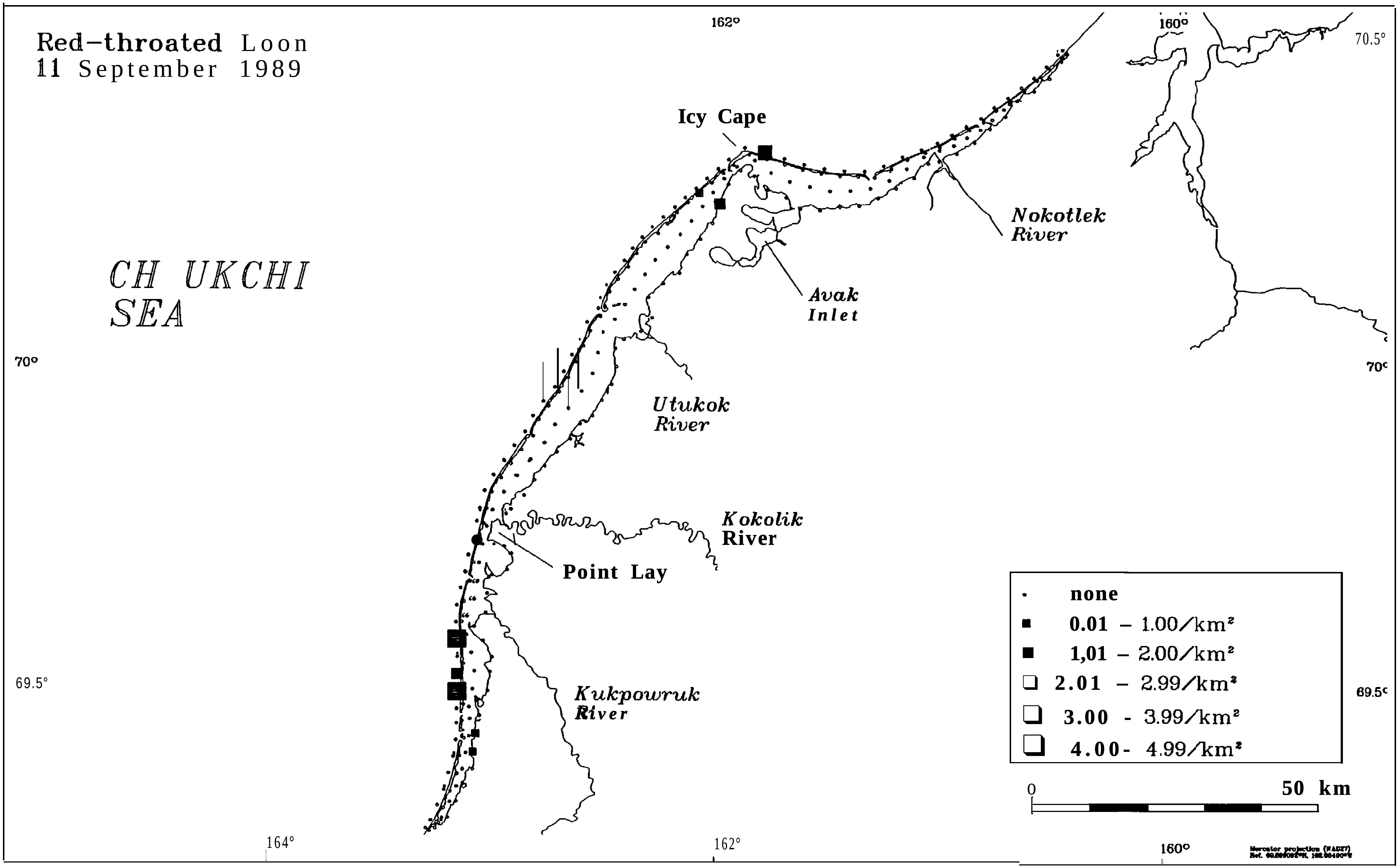

Pacific Loon
8 September 1990
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70.5°
70°
69.5°
none
0.01 – 1.57/km²
1.58 – 3.13/km'
3.14 – 4.70/km²
4.71 - 6.26/km'
6.2? - 7.83/km²
0
50 km

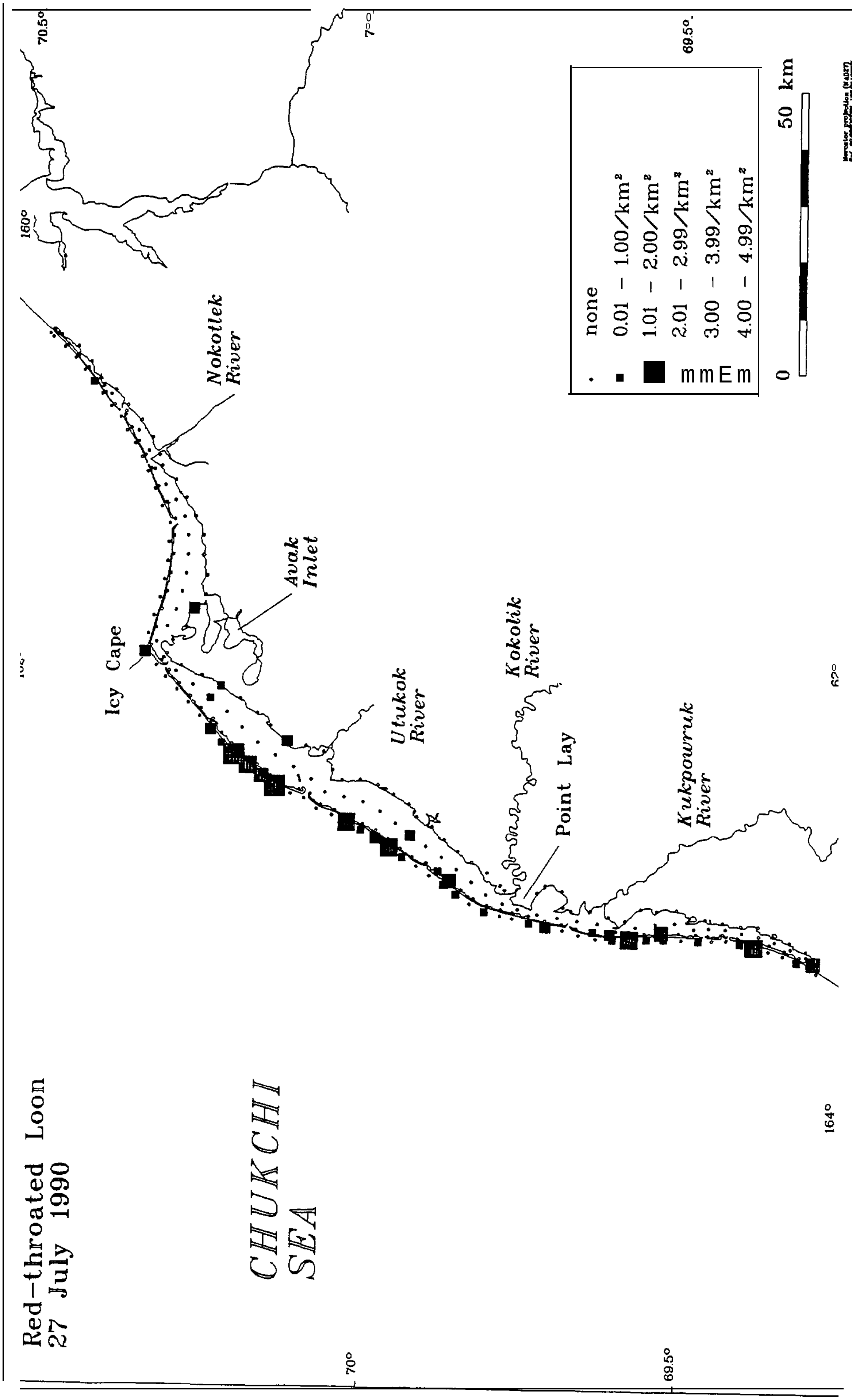

Red-throated Loon
24 August 1989
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 1.00/km²
1.01 - 2.00/km²
2.01 - 2.99/km²
3.00 - 3.99/km²
4.00 - 4.99/km²
0
50 km
70°
69.5°
160°
162°

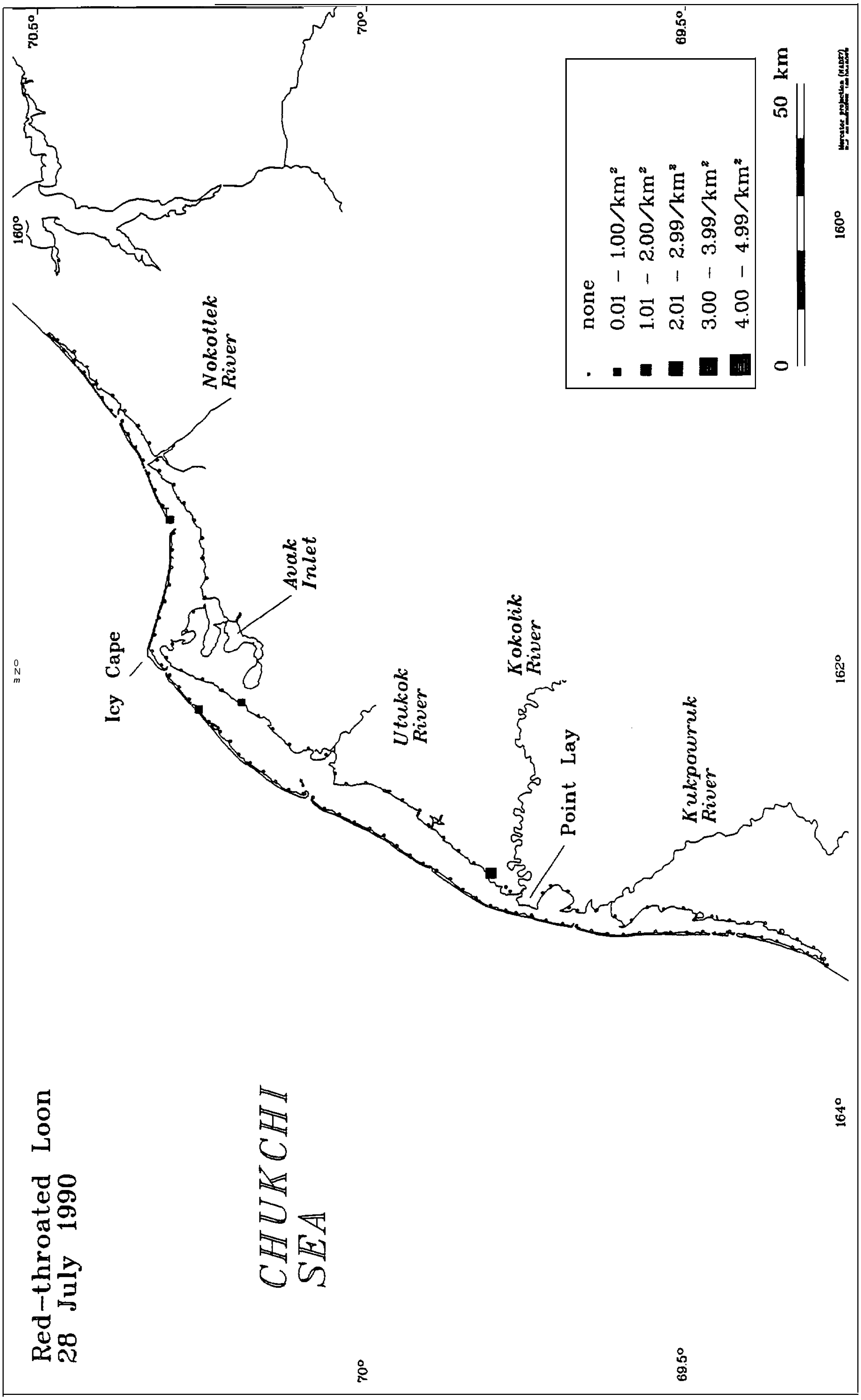

Red-throated Loon
26 August 1989
Icy Cape
CHUKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°.
70°
69.5
69.5°
164°
none
0,01 - LOO/km'
1.01 - 2.00/km²
2,01 - 2.99/km²
3.00 - 3.99/km²
4.00 - 4.99/km²
0
50 km

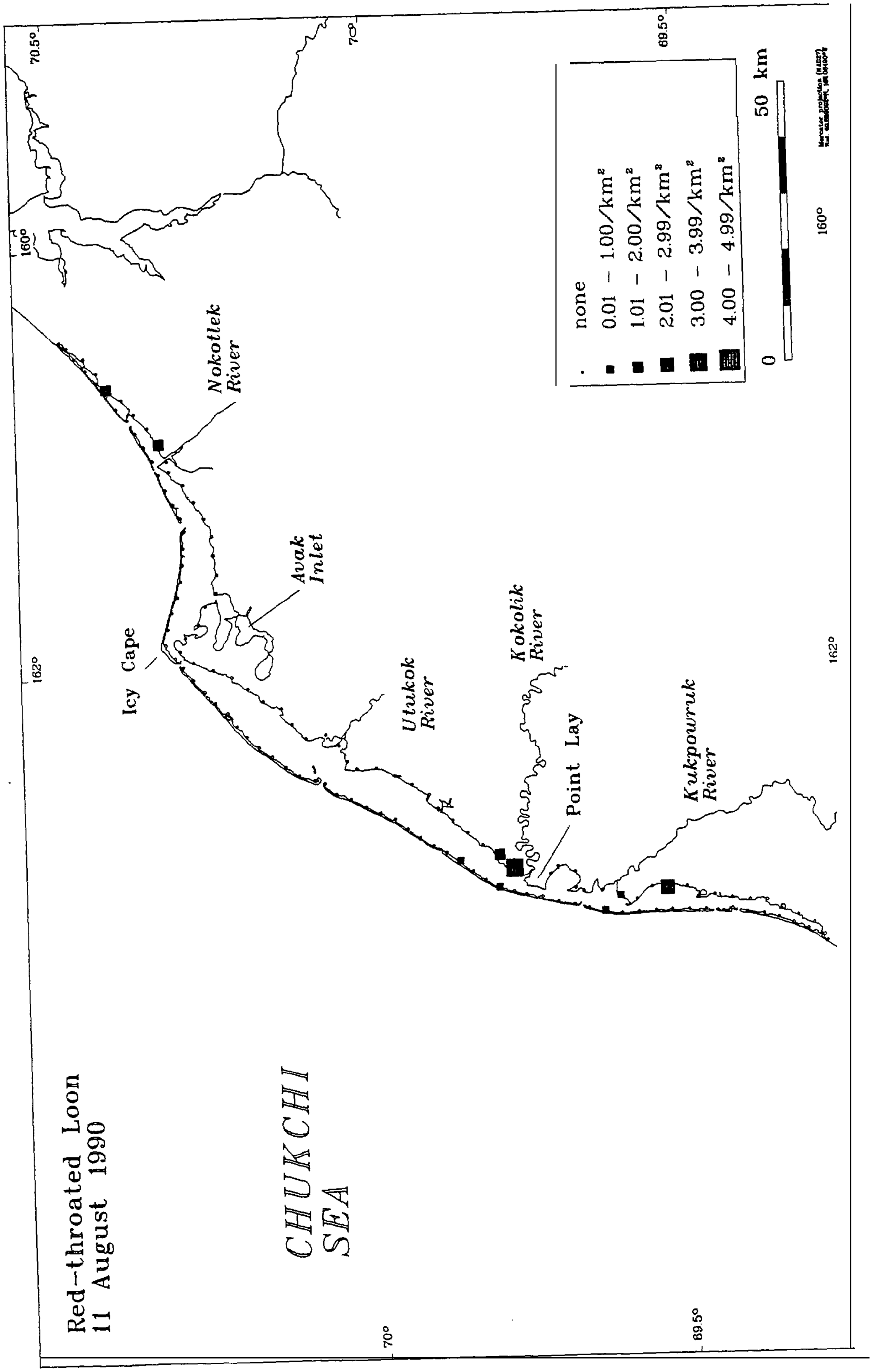

Red-throated Loon
3 September 1989
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 1.00/km²
1.01 – 2.00/km²
2.01 – 2.99/km²
3.00 – 3.99/km²
4.00 – 4.99/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

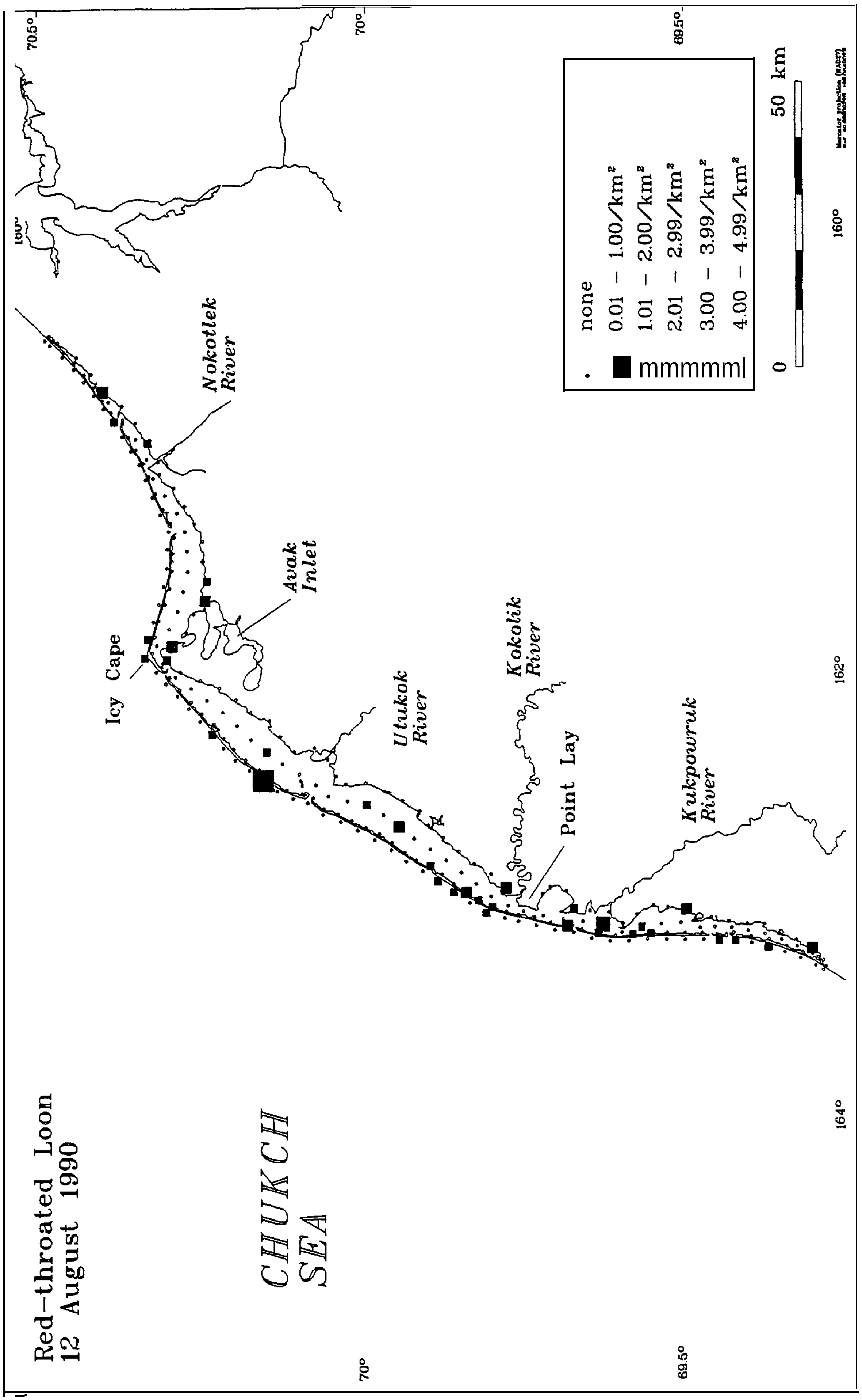

Red-throated Loon
4 September 1989
CH UKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
160°
70.5°
70°
70
.695°
164°
162°
160°
none
0.01 - 1.00/km²
1.01 – 2.00/km'
2.01 – 2.99/km'
3.00 - 3.99/km²
4.00- 4.99/km'
0
50 km

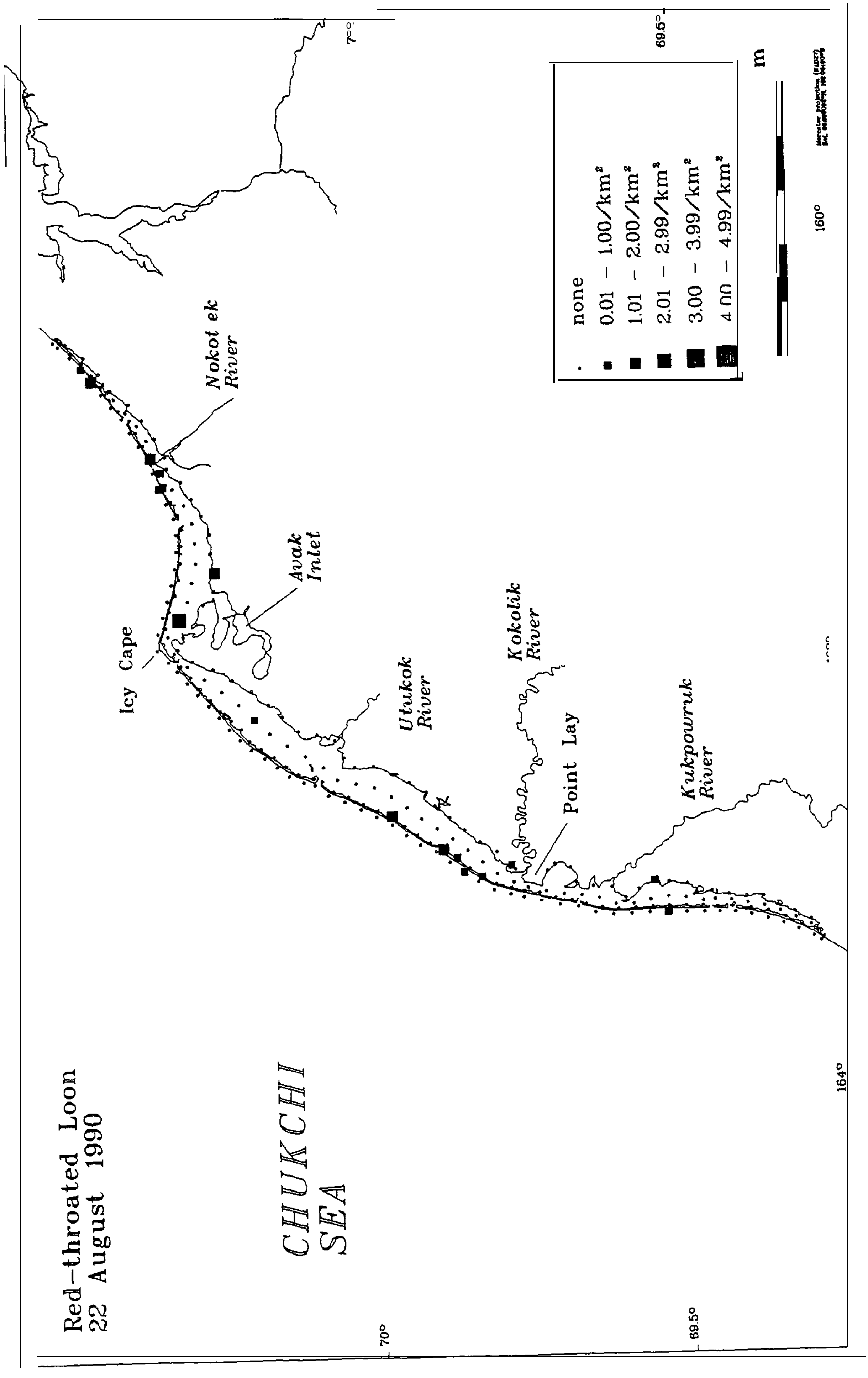

Red-throated Loon
11 September 1989
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 1.00/km²
1,01 – 2.00/km²
2.01 – 2.99/km²
3.00 - 3.99/km²
4.00- 4.99/km²
0
50 km
162°
160°
70.5°
70°
69.5°
164°

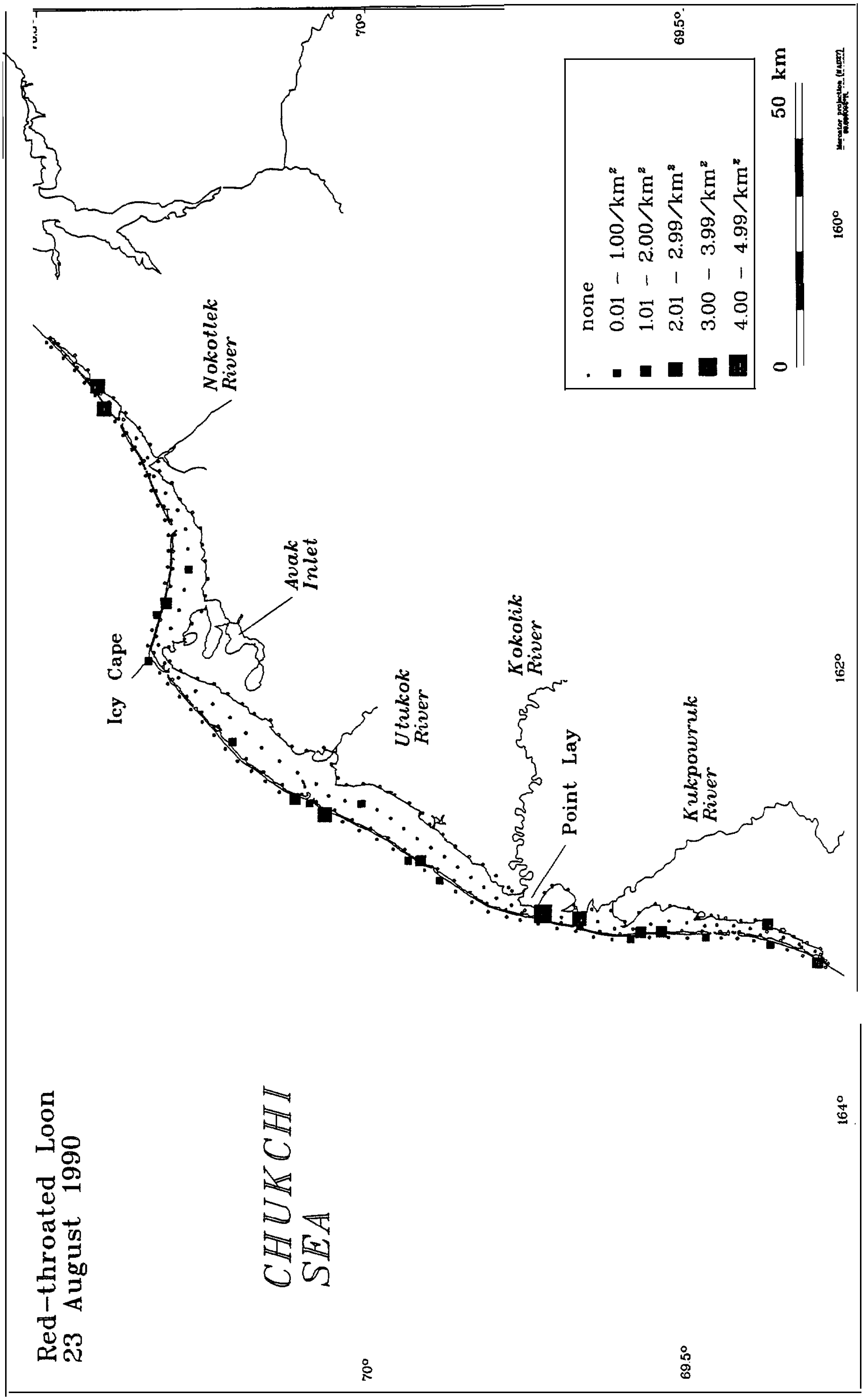

Red-throated Loon
27 July 1990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 1.00/km²
1.01 - 2.00/km²
2.01 - 2.99/km²
3.00 - 3.99/km²
4.00 - 4.99/km²
0
50 km
70.5°
70°
69.5°
160°
164°

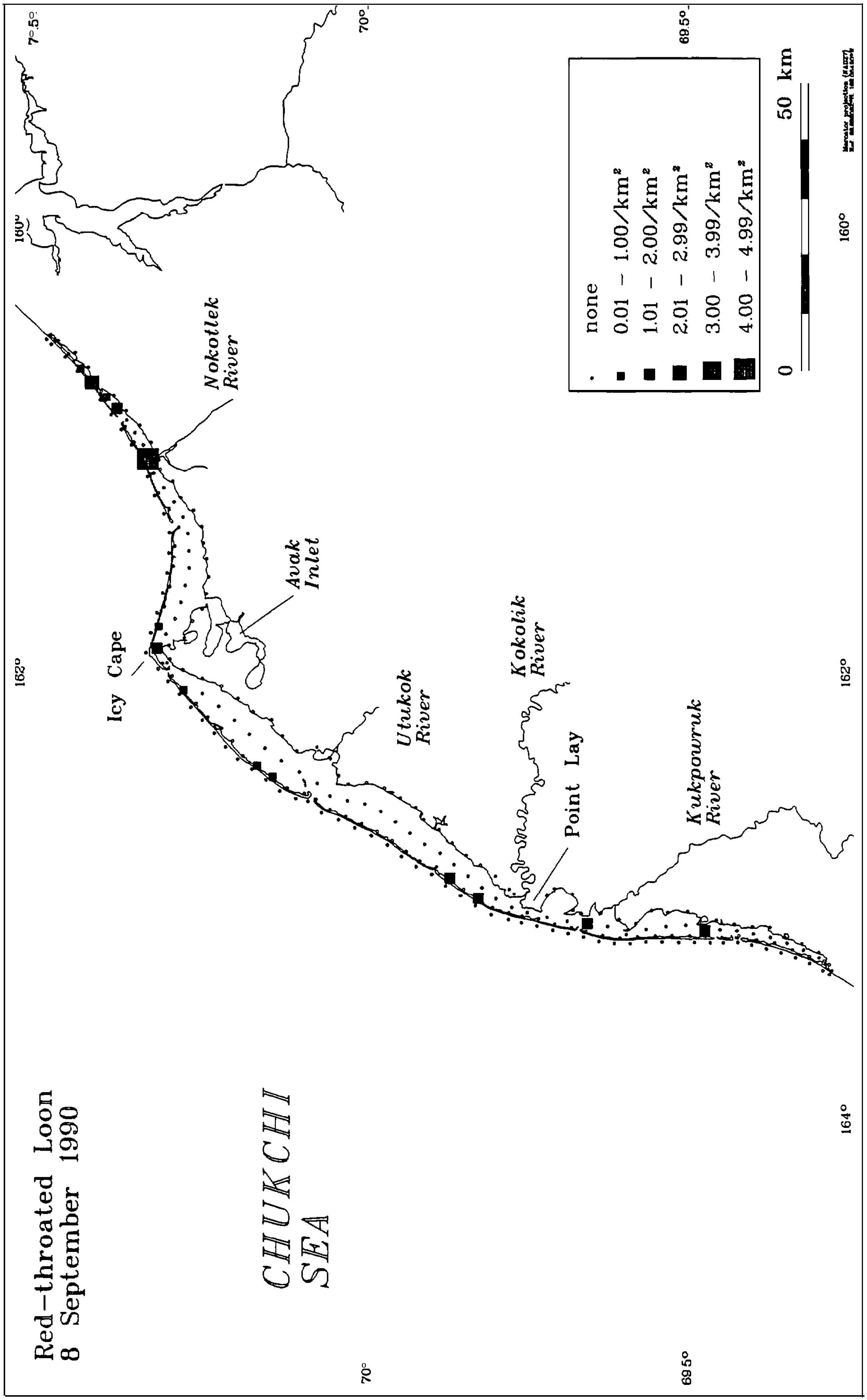

Red-throated Loon
28 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 1.00/km^2
1.01 - 2.00/km^2
2.01 - 2.99/km^2
3.00 - 3.99/km^2
4.00 - 4.99/km^2
0
50 km
70.5°
70°
69.5°
160°
162°
164°

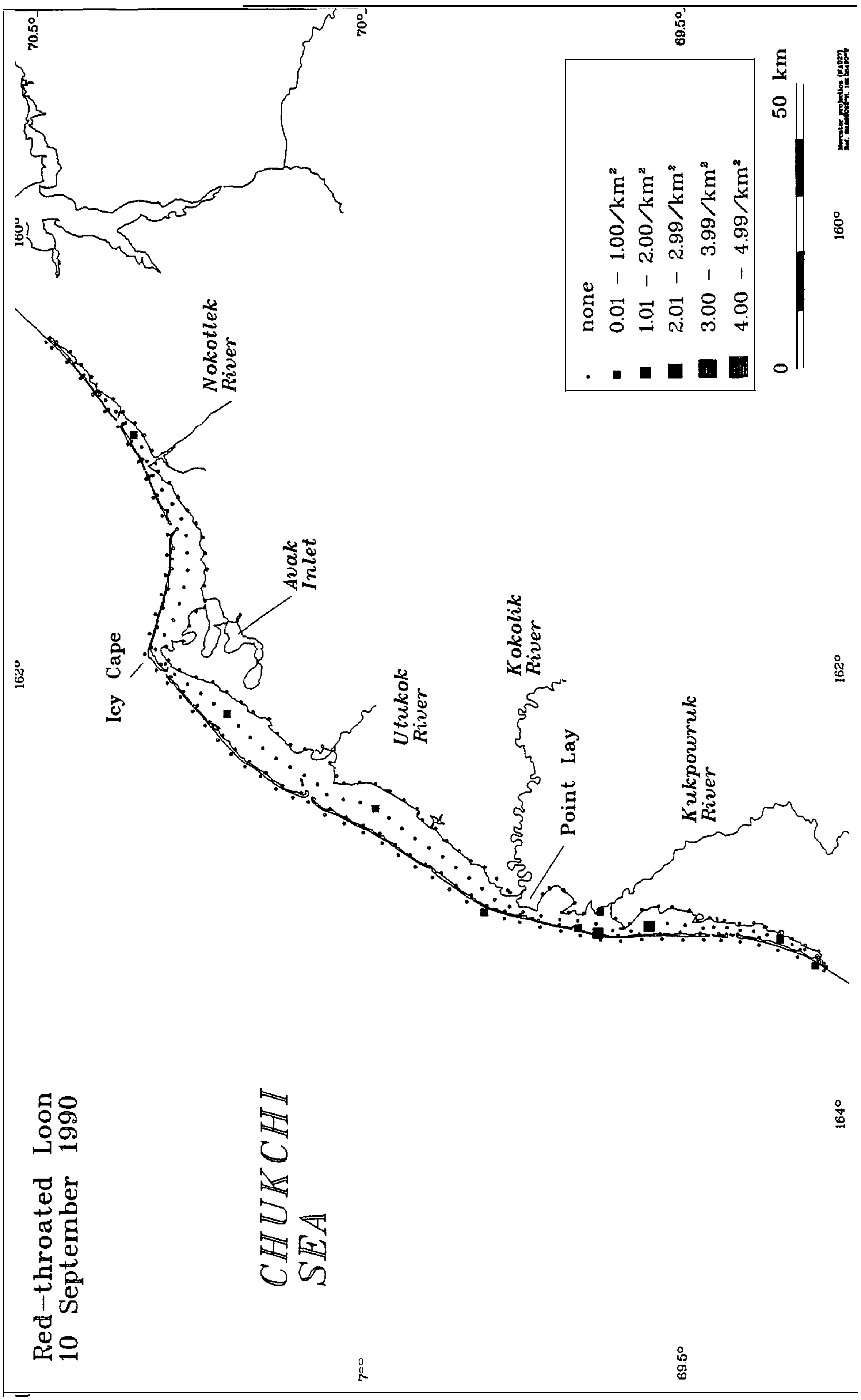

Red-throated Loon
11 August 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 1.00/km²
1.01 - 2.00/km²
2.01 - 2.99/km²
3.00 - 3.99/km²
4.00 - 4.99/km²
0
50 km
70.5°
70°
69.5°
160°
162°

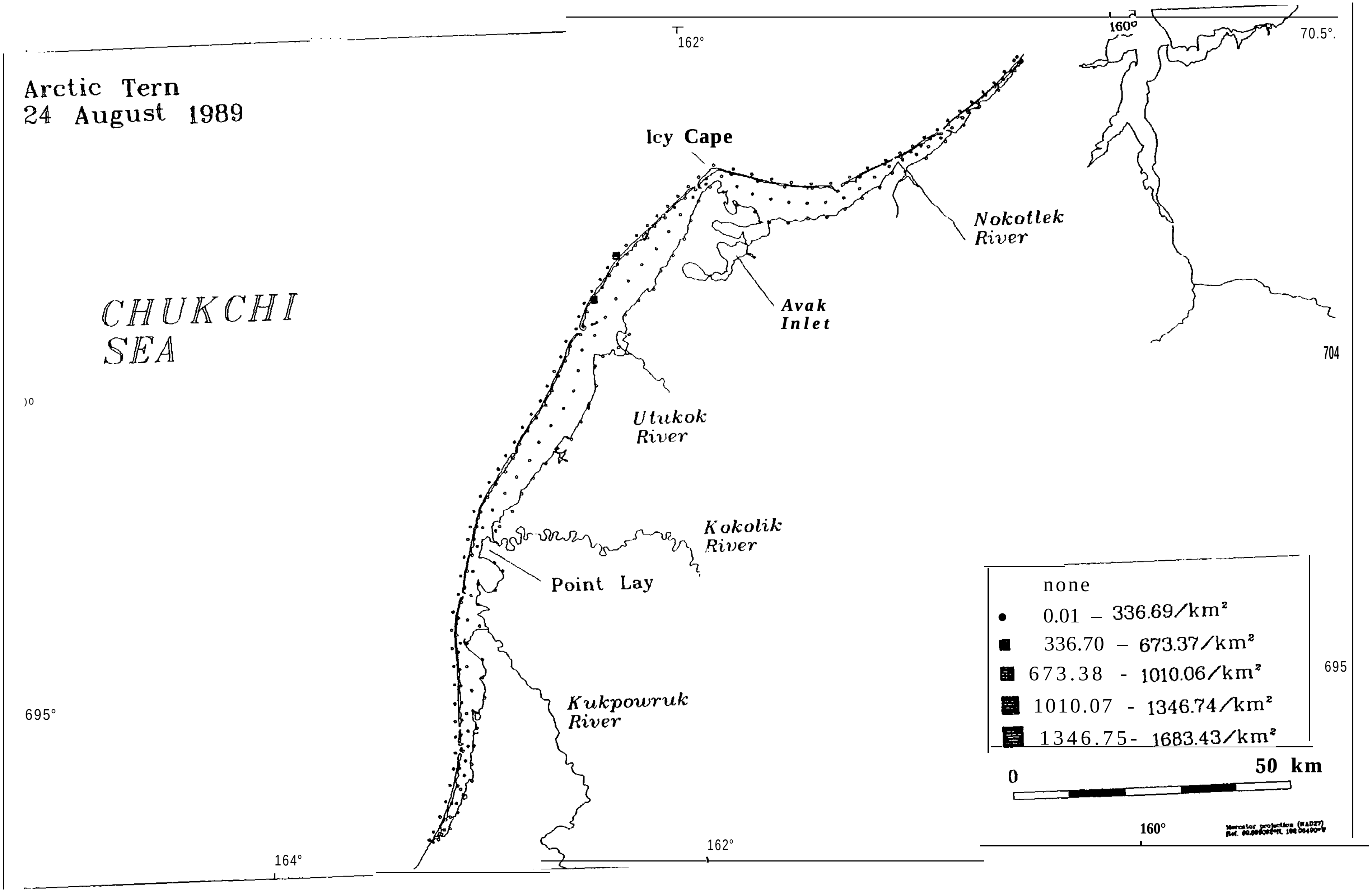

Red-throated Loon
12 August 1990
CHUKCH
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 1.00/km^2
1.01 - 2.00/km^2
2.01 - 2.99/km^2
3.00 - 3.99/km^2
4.00 - 4.99/km^2
0
50 km
70.5°
70°
69.5°
160°
162°
164°

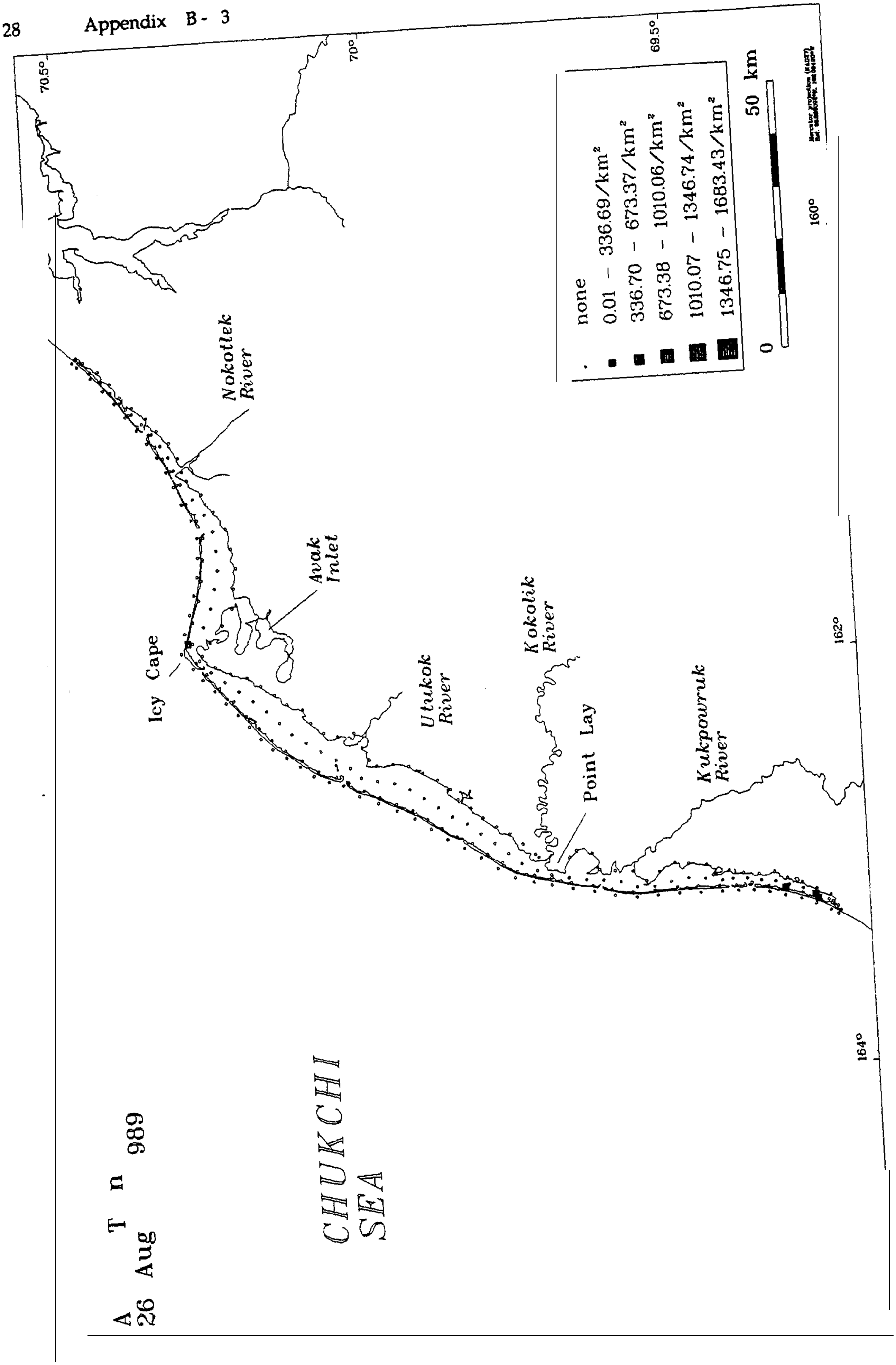

Red-throated Loon
22 August 1990
CHUKCHI
SEA
Icy Cape
Avak
Inlet
Nokotlek
River
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 1.00/km²
1.01 - 2.00/km²
2.01 - 2.99/km²
3.00 - 3.99/km²
4.00 - 4.99/km²
70°
69.5°
164°
160°

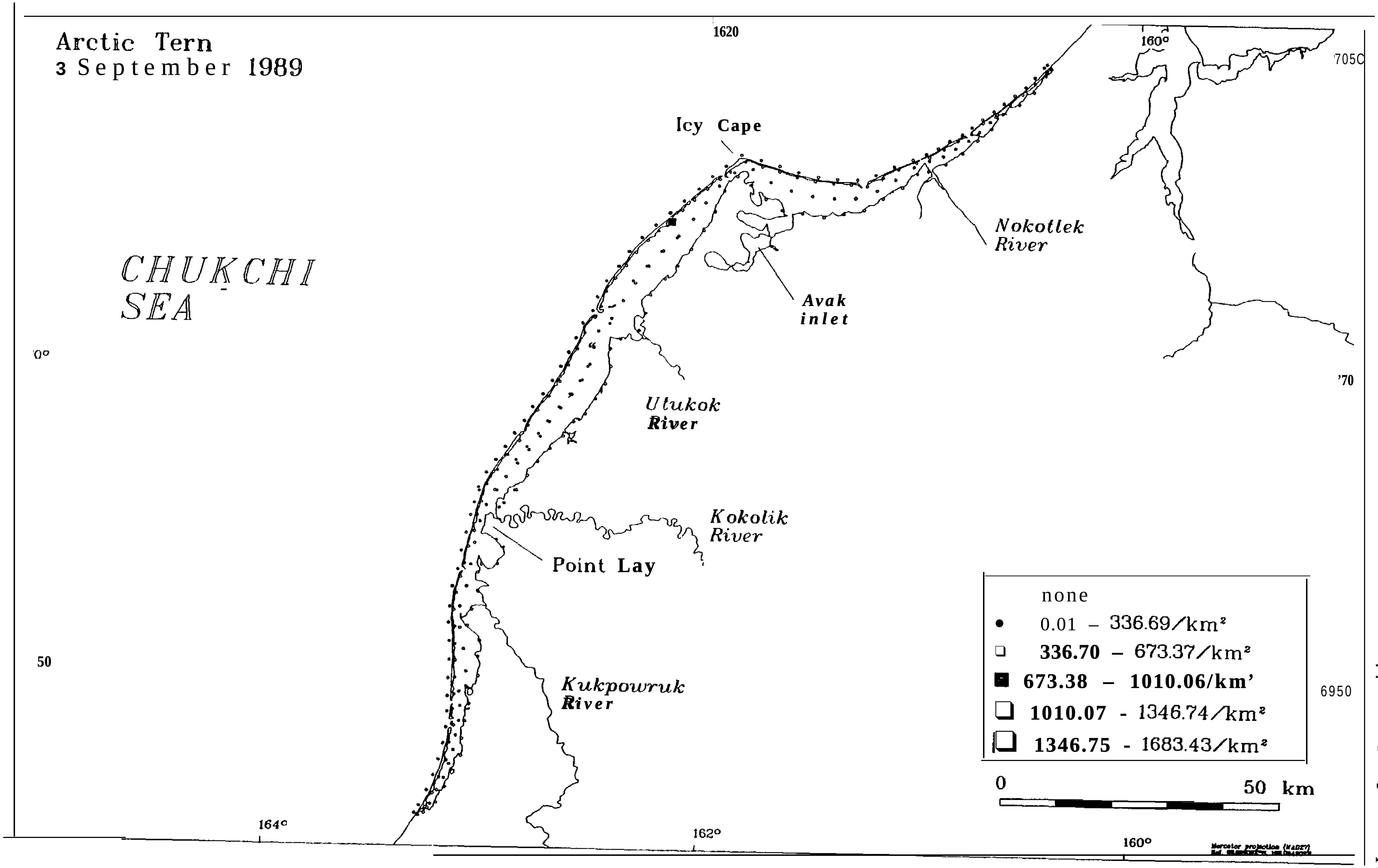

Red-throated Loon
23 August 1990
CHUKCHI
SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 1.00/km²
1.01 - 2.00/km²
2.01 - 2.99/km²
3.00 - 3.99/km²
4.00 - 4.99/km²
0
50 km
70°
69.5°
160°
162°
164°

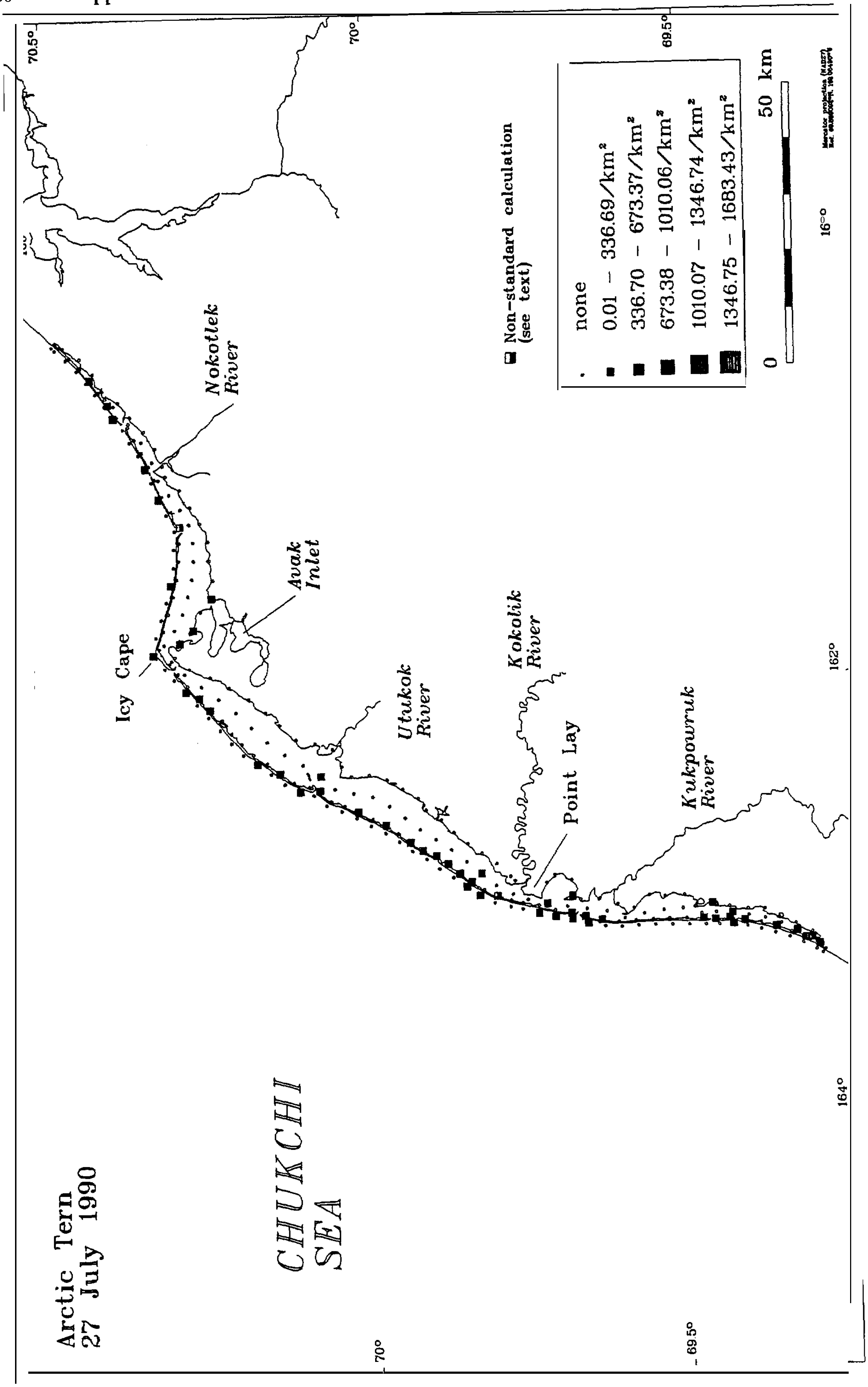

Red-throated Loon
8 September 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 1.00/km²
1.01 - 2.00/km²
2.01 - 2.99/km²
3.00 - 3.99/km²
4.00 - 4.99/km²
0
50 km
160°
162°
164°
70°
69.5°

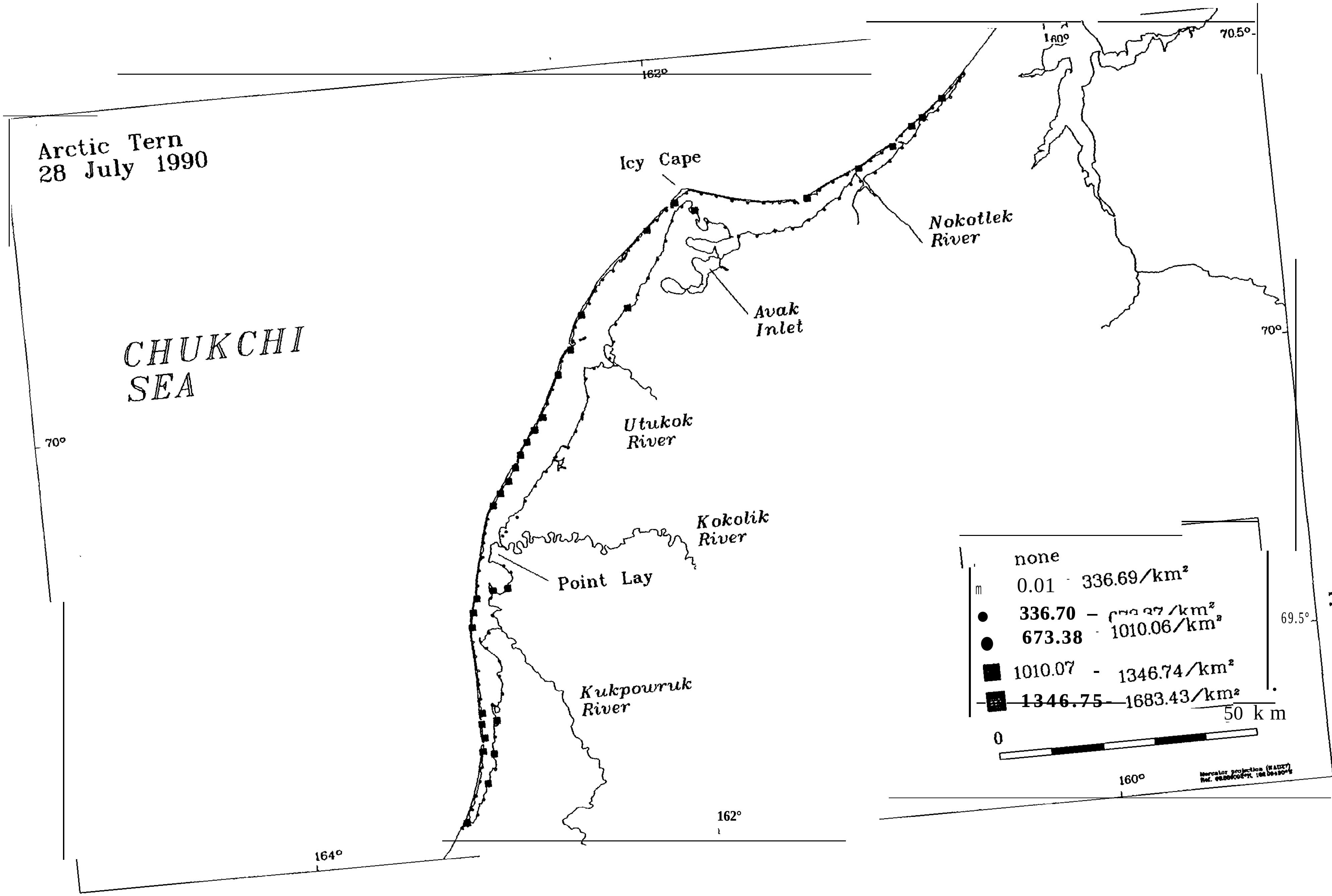

Red-throated Loon
10 September 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 1.00/km²
1.01 - 2.00/km²
2.01 - 2.99/km²
3.00 - 3.99/km²
4.00 - 4.99/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

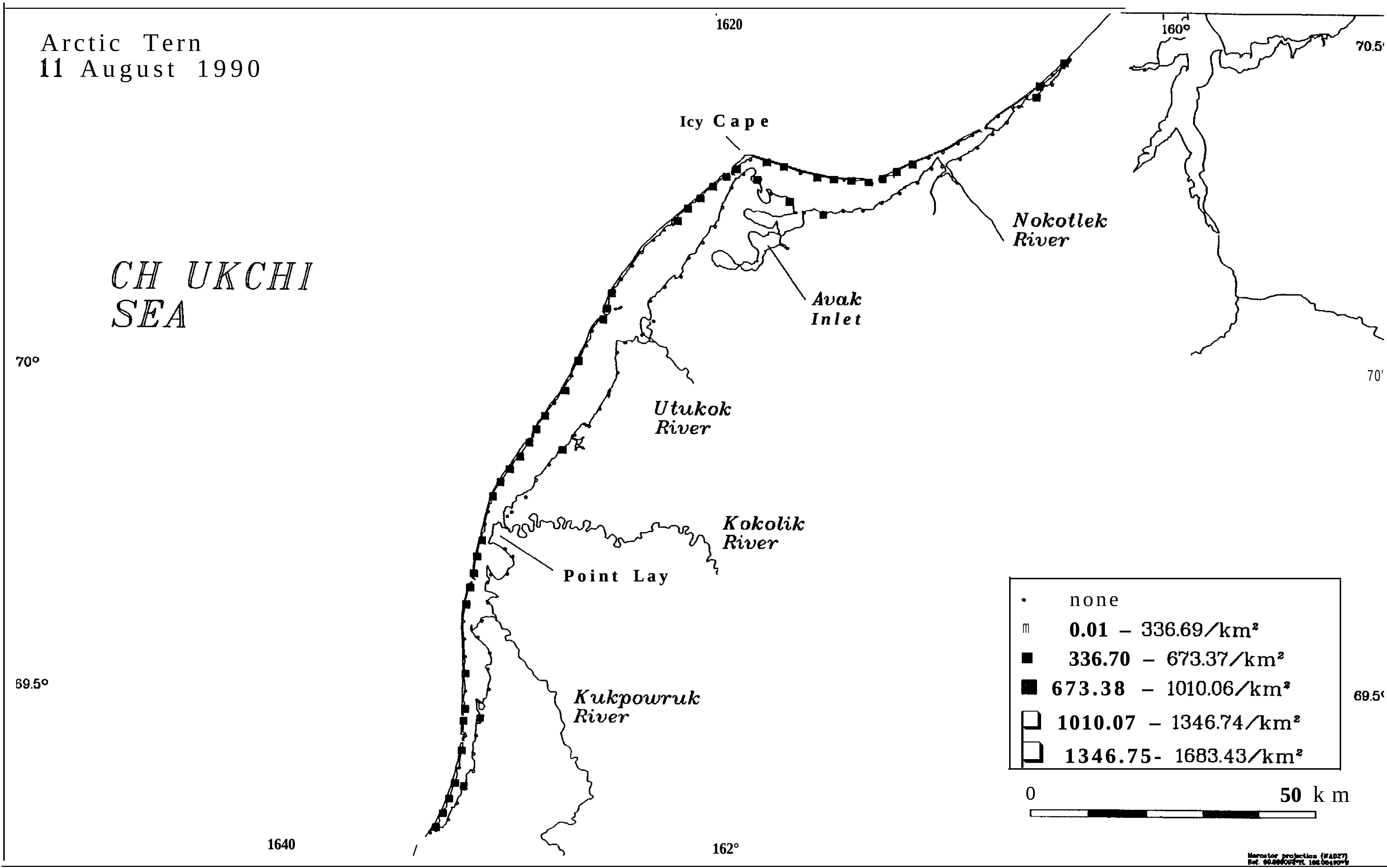

Arctic Tern
24 August 1989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
160°
70.5°.
704
695
695°
164°
162°
160°
none
0.01 – 336.69/km²
336.70 – 673.37/km²
673.38 - 1010.06/km²
1010.07 - 1346.74/km²
1346.75- 1683.43/km²
0
50 km

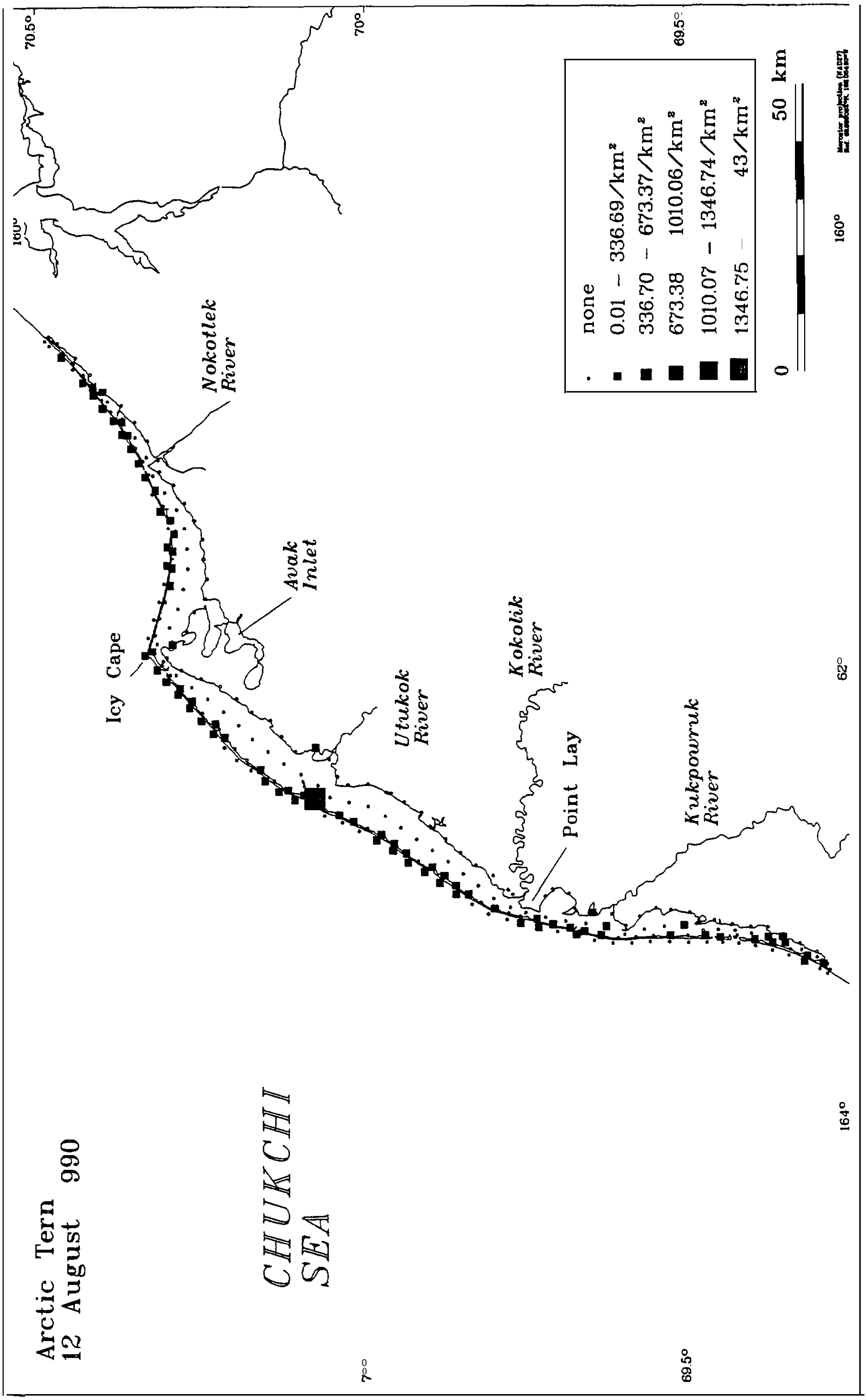

A T n
26 Aug 989
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
70.5°
70°
69.5°
160°
162°
164°
none
0.01 - 336.69/km²
336.70 - 673.37/km²
673.38 - 1010.06/km²
1010.07 - 1346.74/km²
1346.75 - 1683.43/km²
0
50 km

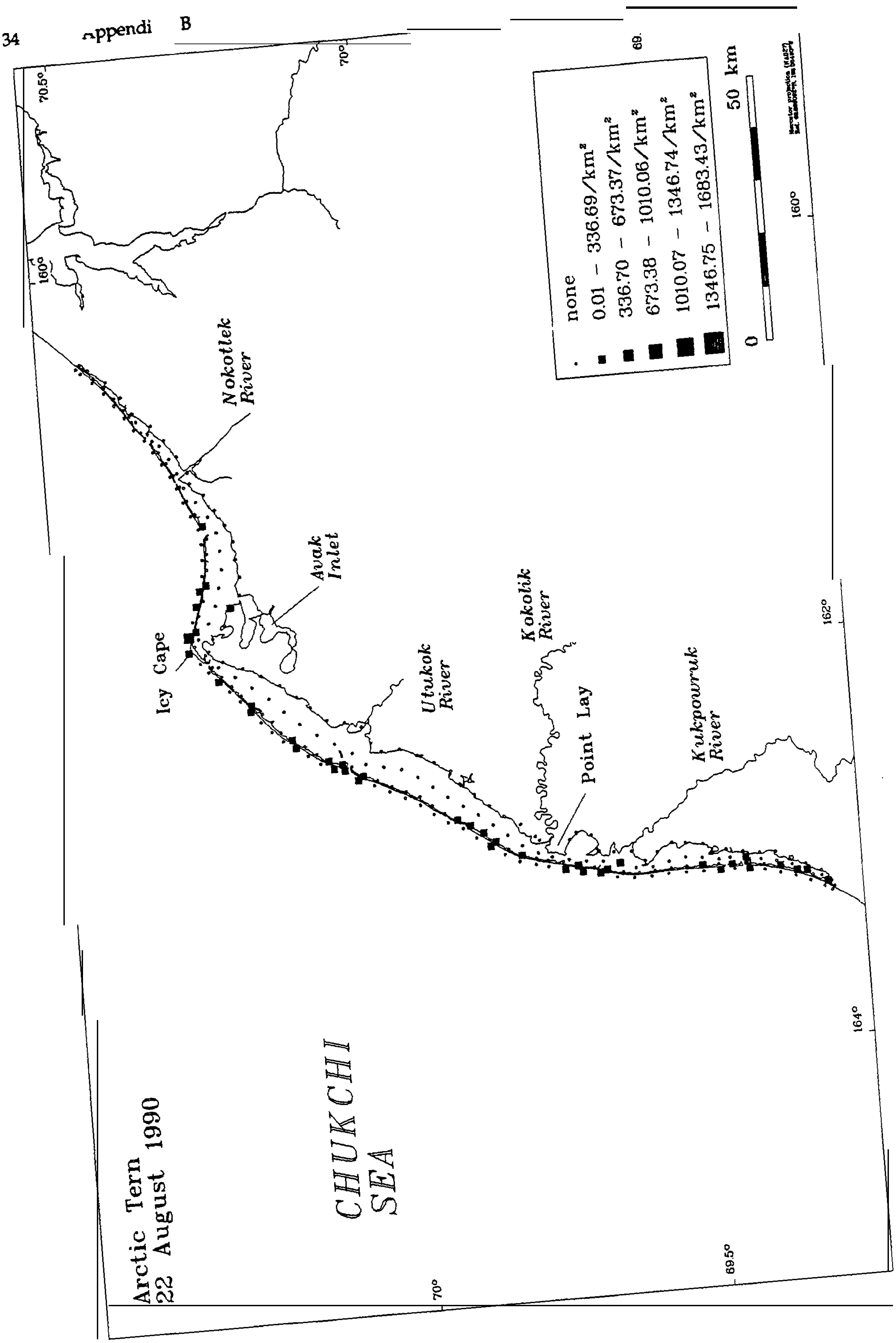

Arctic Tern
3 September 1989
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 336.69/km²
336.70 – 673.37/km²
673.38 – 1010.06/km²
1010.07 - 1346.74/km²
1346.75 - 1683.43/km²
0
50 km
164°
162°
160°

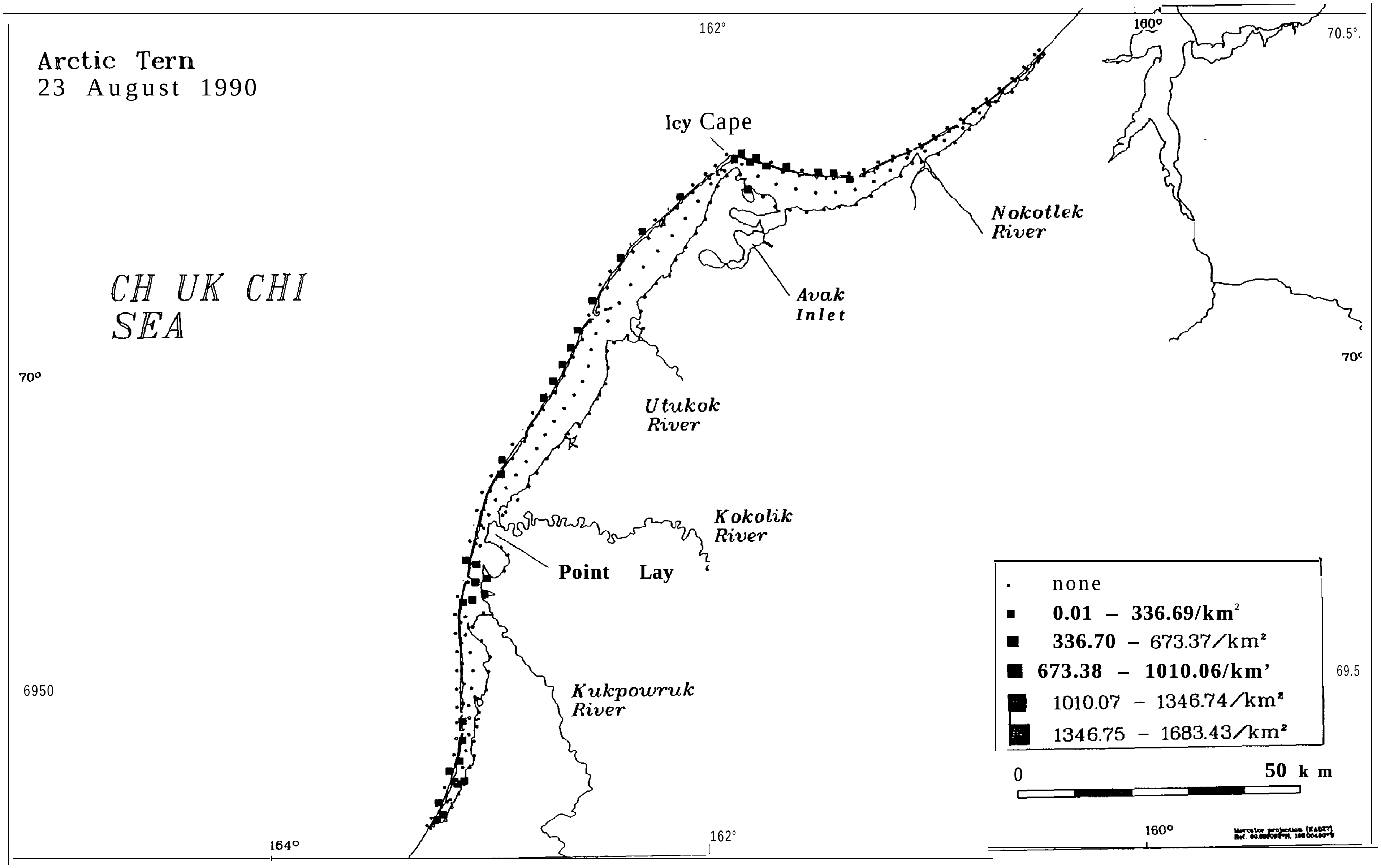

Arctic Tern
27 July 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
Non-standard calculation
(see text)
none
0.01 - 336.69/km²
336.70 - 673.37/km²
673.38 - 1010.06/km²
1010.07 - 1346.74/km²
1346.75 - 1683.43/km²
0
50 km
70.5°
70°
69.5°
162°
164°

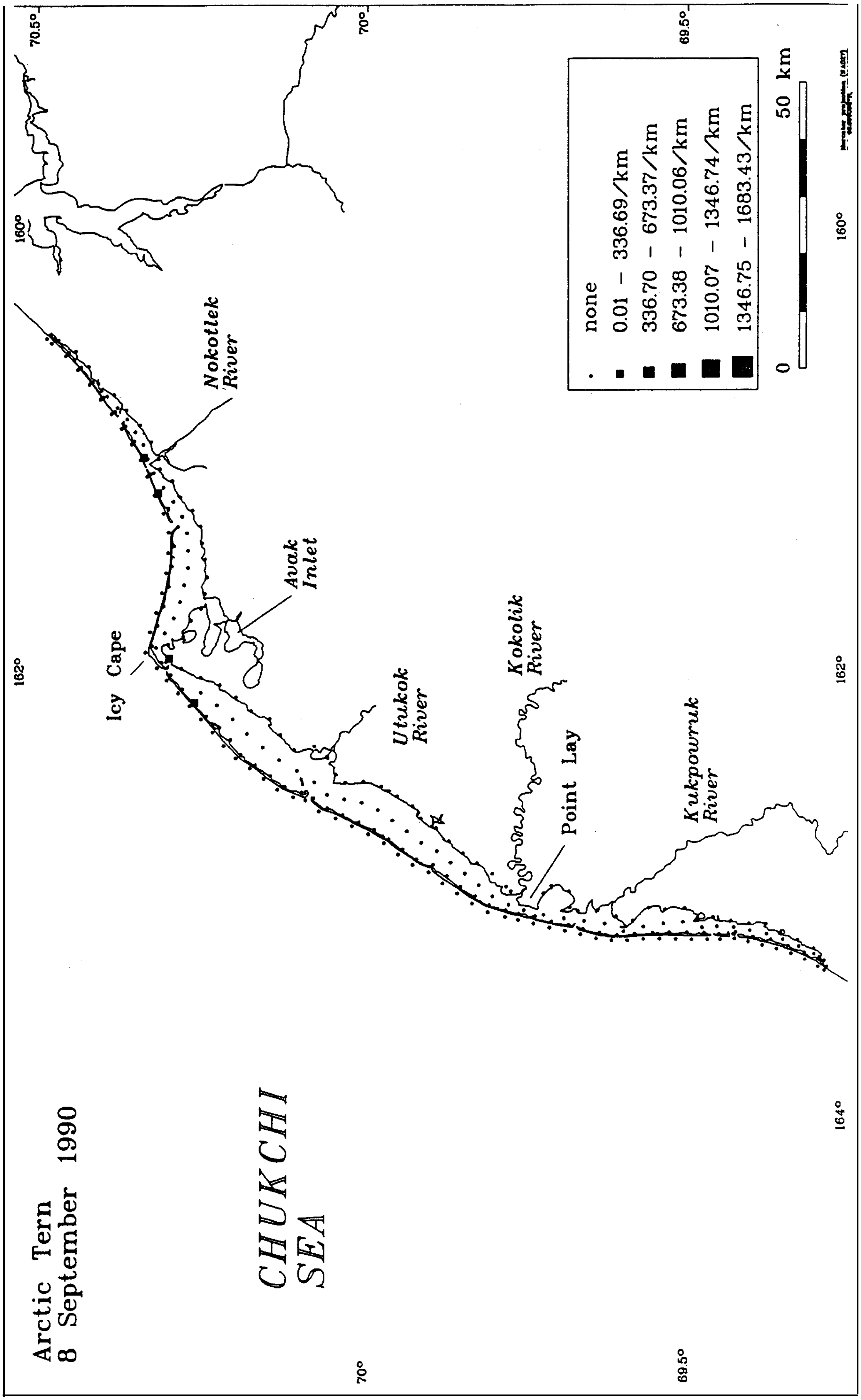

Arctic Tern
28 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
70.5°
160°
162°
70°
69.5°
164°
none
0.01 - 336.69/km²
336.70 –
673.38 - 1010.06/km²
1010.07 - 1346.74/km²
1346.75 - 1683.43/km²
0
50 km

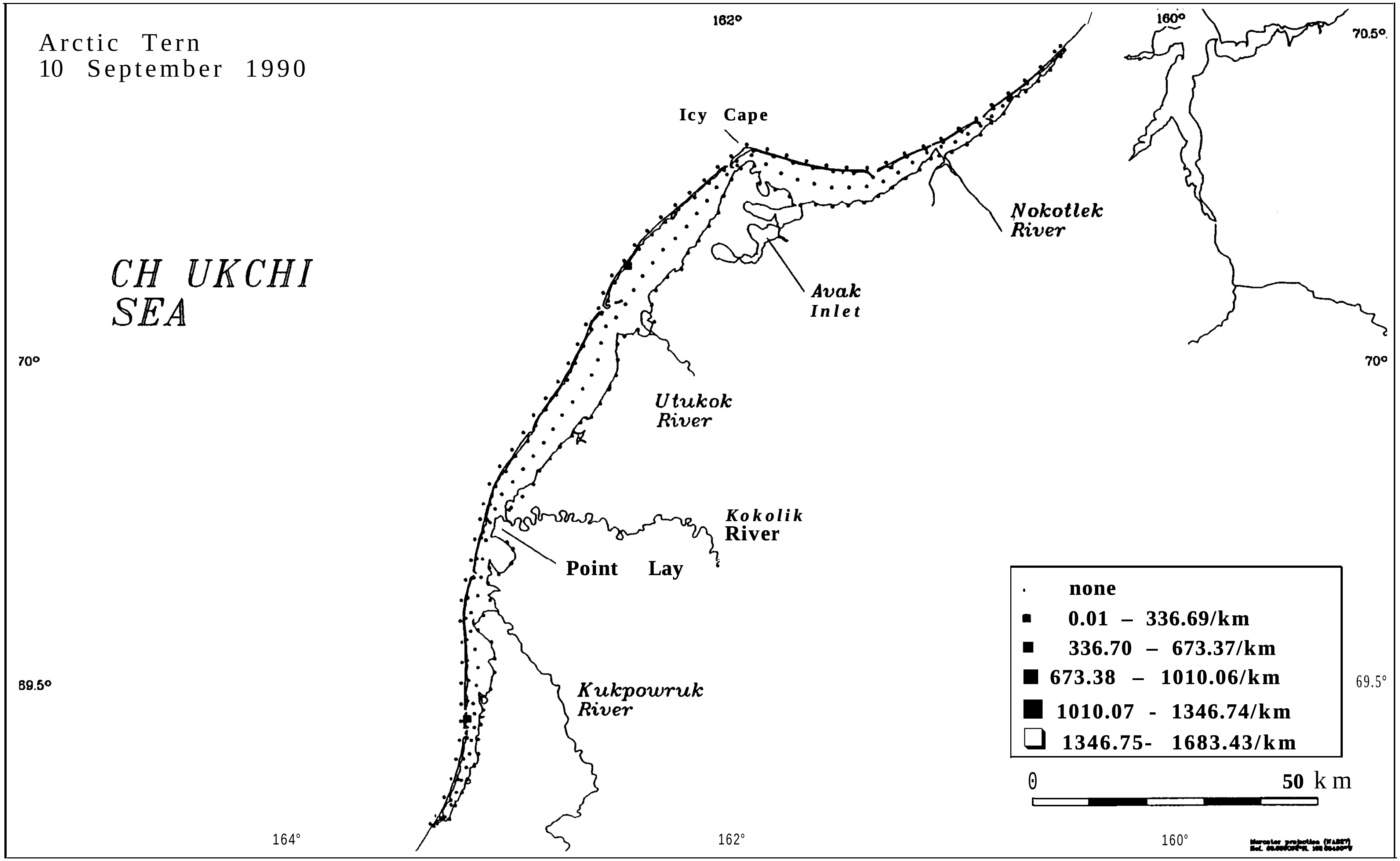

Arctic Tern
11 August 1990
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
1620
160°
70.5°
70°
70'
69.5°
69.5°
1640
162°
none
0.01 – 336.69/km²
336.70 – 673.37/km²
673.38 – 1010.06/km²
1010.07 – 1346.74/km²
1346.75- 1683.43/km²
0
50 k m

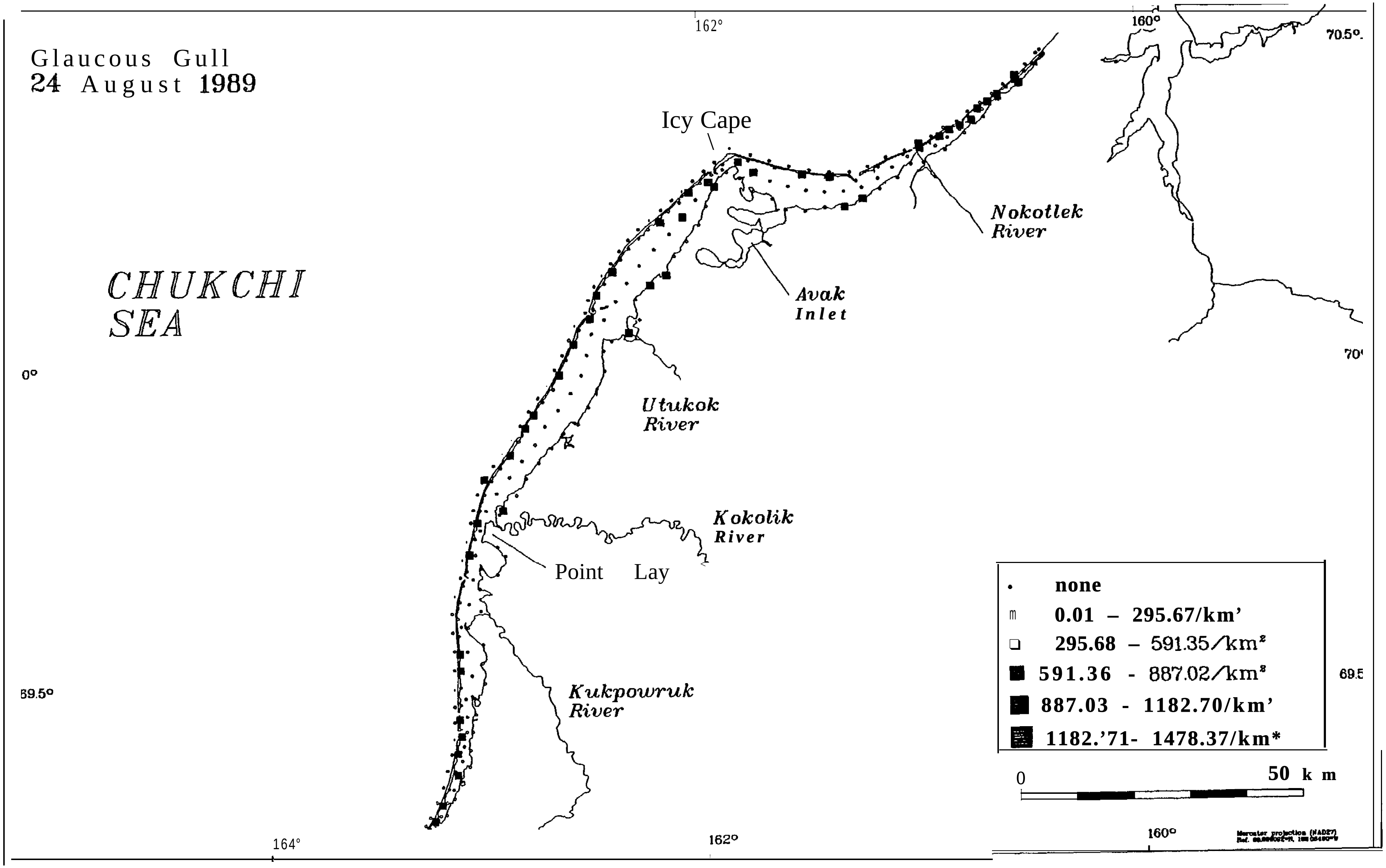

Arctic Tern
12 August 990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 336.69/km²
336.70 – 673.37/km²
673.38 1010.06/km²
1010.07 – 1346.74/km²
1346.75 — 43/km²
0
50 km
70.5°
70°
69.5°
164°
62°
160°

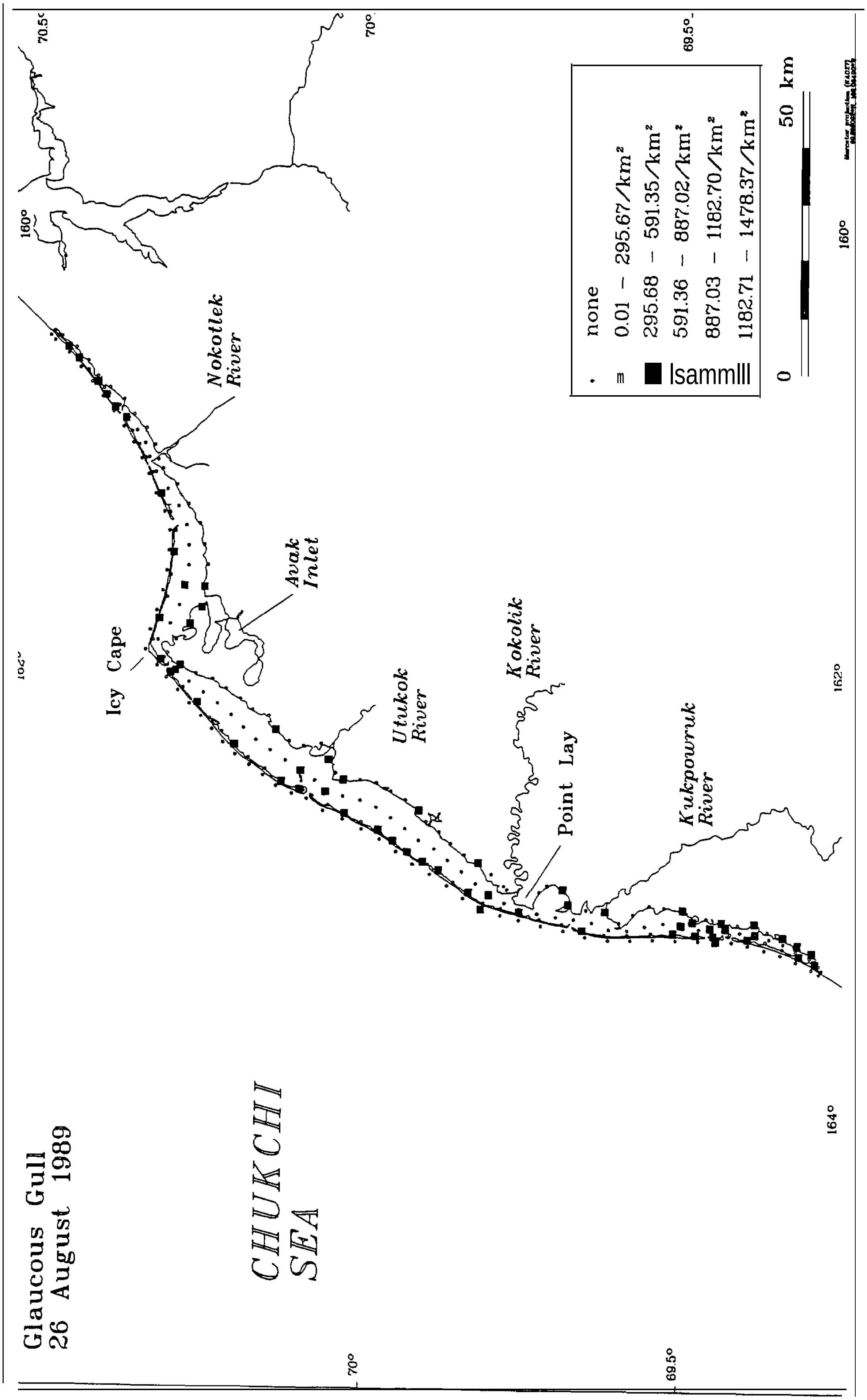

Arctic Tern
22 August 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 336.69/km²
336.70 - 673.37/km²
673.38 - 1010.06/km²
1010.07 - 1346.74/km²
1346.75 - 1683.43/km²
0
50 km
70.5°
160°
70°
69.
162°
164°
69.5°

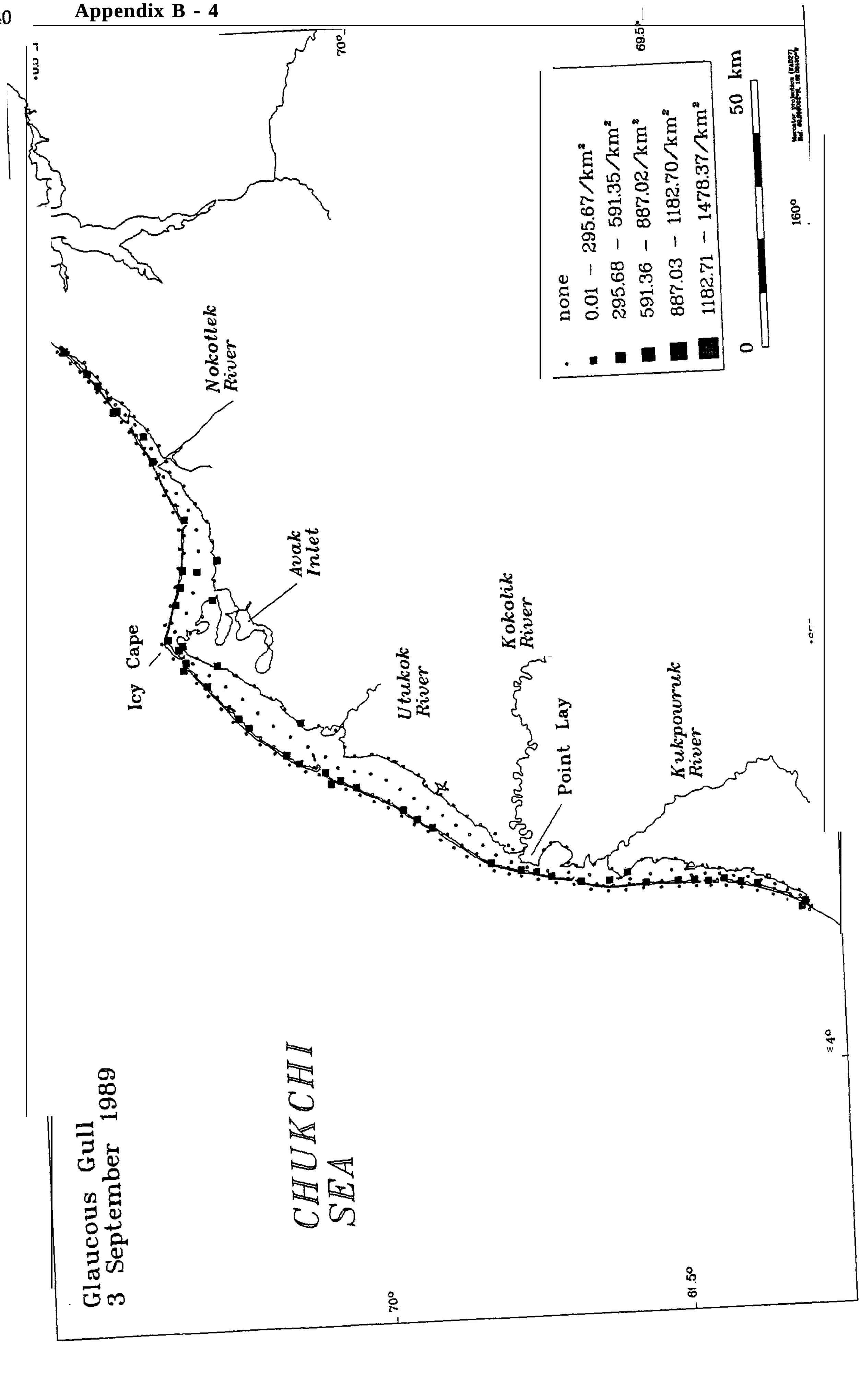

Arctic Tern
23 August 1990
Icy Cape
CH UK CHI
SEA
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 336.69/km²
336.70 – 673.37/km²
673.38 – 1010.06/km'
1010.07 – 1346.74/km²
1346.75 – 1683.43/km²
0
50 km
162°
160°
164°
70.5°.
70°
69.5
6950

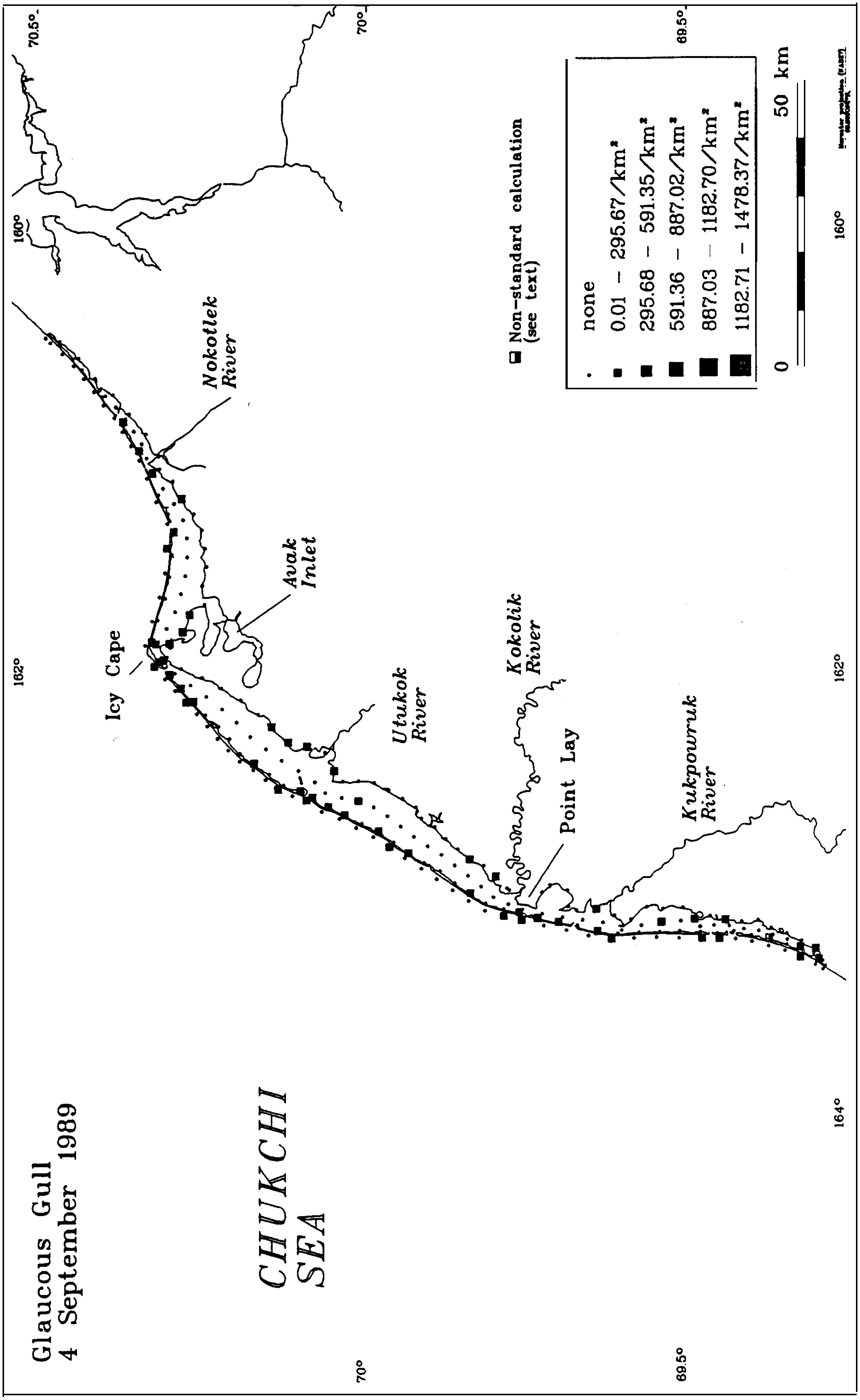

Arctic Tern
8 September 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 336.69/km
336.70 – 673.37/km
673.38 – 1010.06/km
1010.07 – 1346.74/km
1346.75 – 1683.43/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

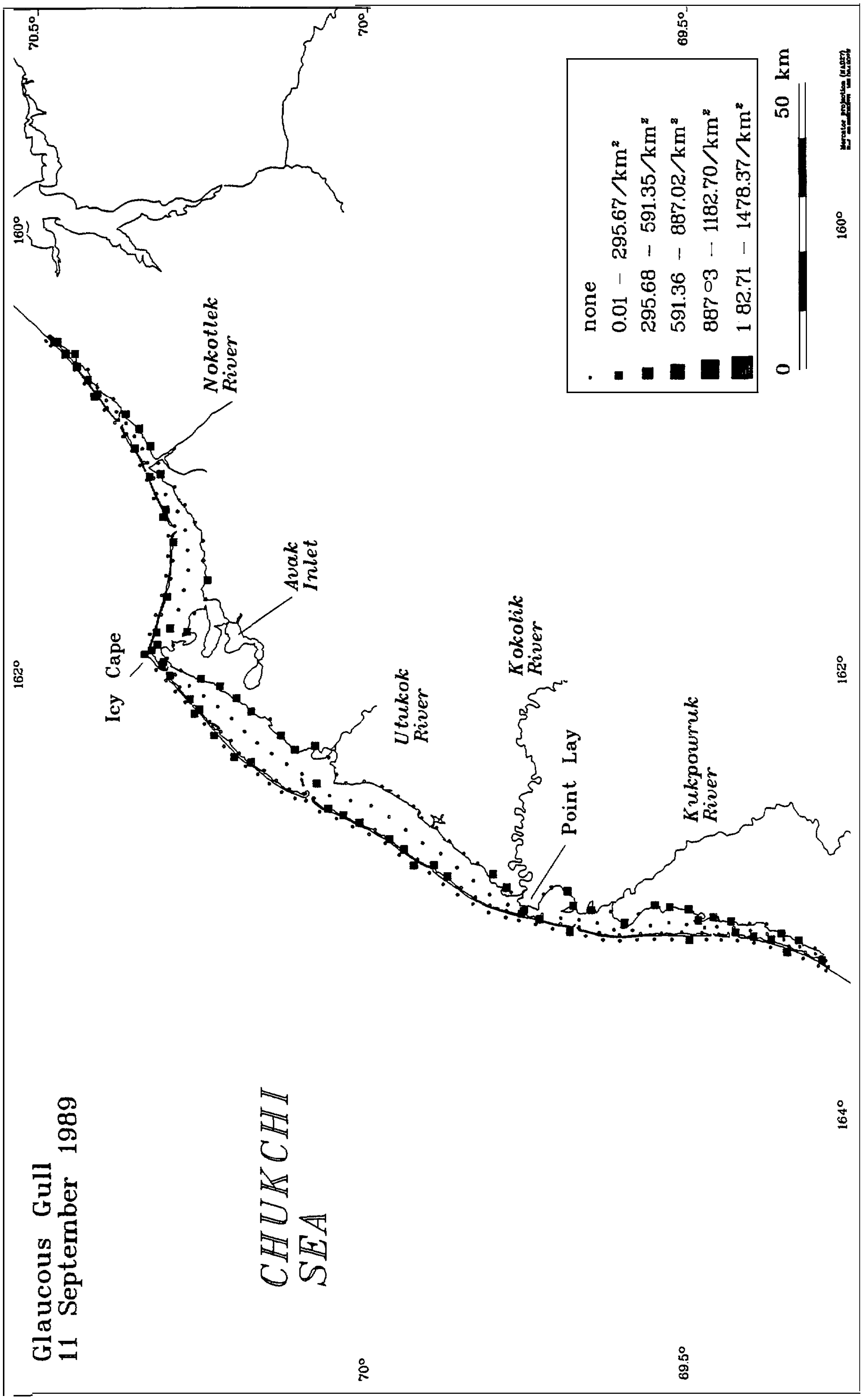

Arctic Tern
10 September 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
69.5°
164°
none
0.01 – 336.69/km
336.70 – 673.37/km
673.38 – 1010.06/km
1010.07 - 1346.74/km
1346.75- 1683.43/km
0
50 km

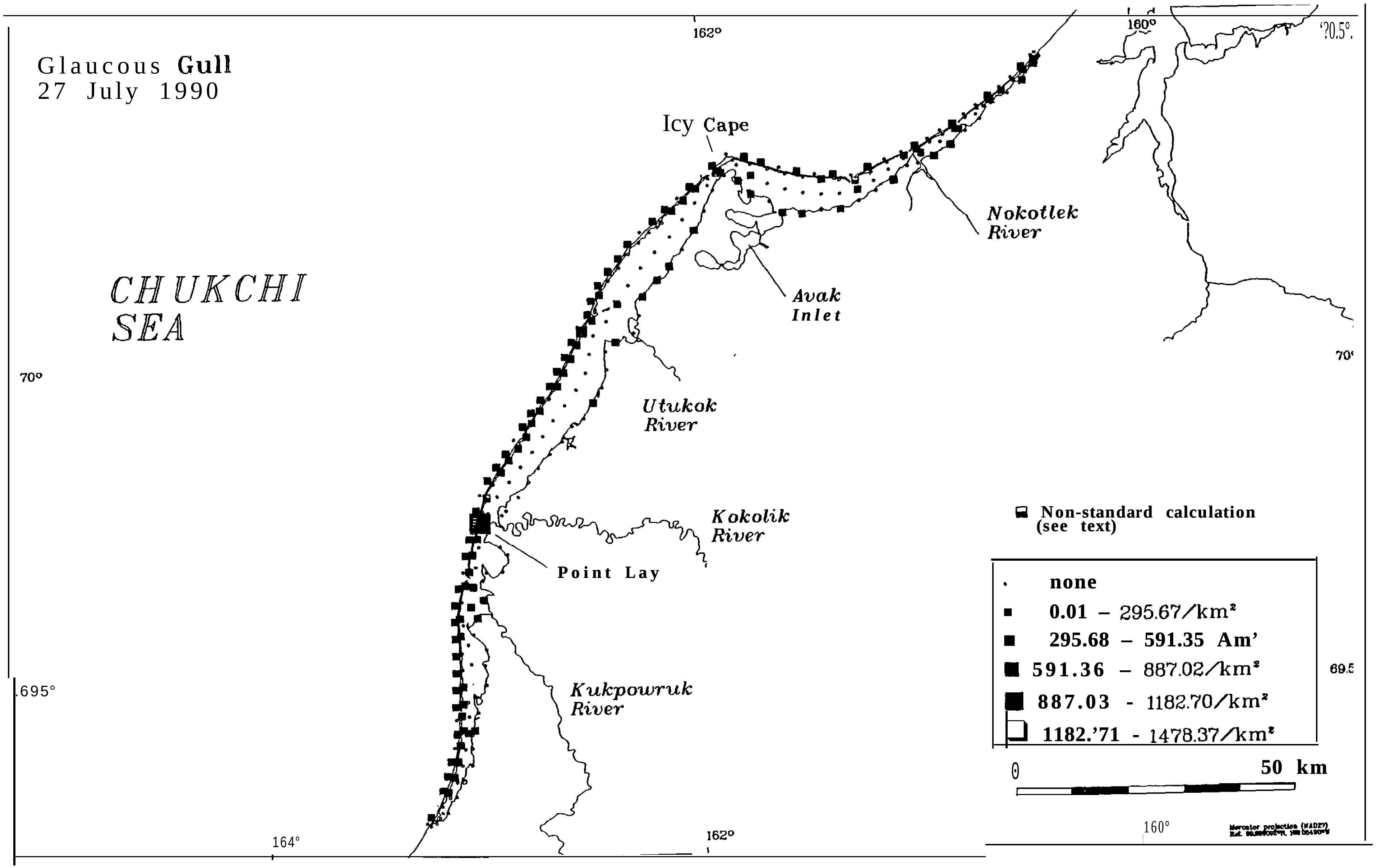

Glaucous Gull
24 August 1989
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70.5°
70°
69.5°
• none
0.01 – 295.67/km'
295.68 – 591.35/km²
591.36 - 887.02/km²
887.03 - 1182.70/km'
1182.'71- 1478.37/km*
0
50 km

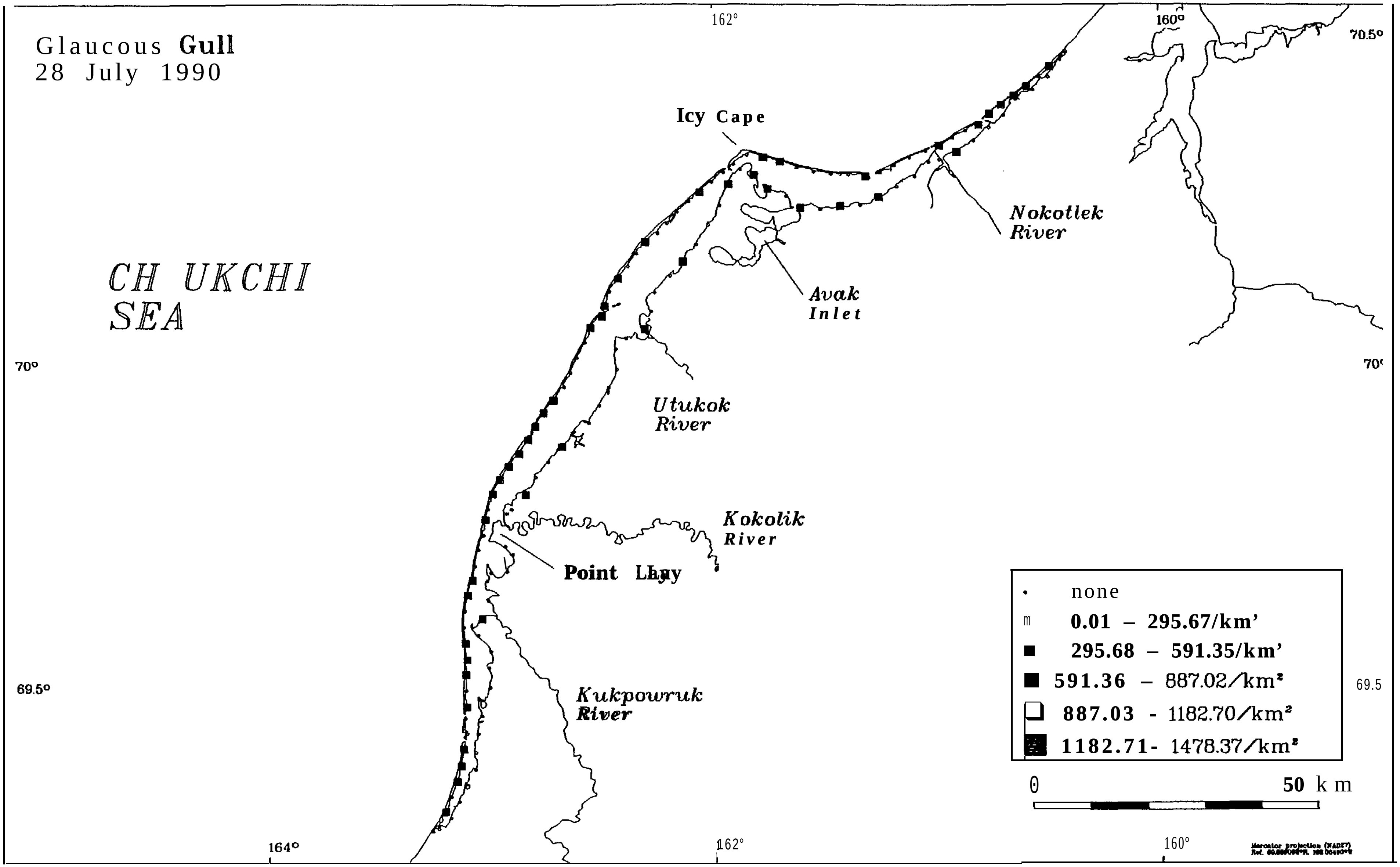

Glaucous Gull
26 August 1989
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 295.67/km²
295.68 – 591.35/km²
591.36 – 887.02/km²
887.03 – 1182.70/km²
1182.71 – 1478.37/km²
0
50 km
70°
69.5°
160°
162°
164°

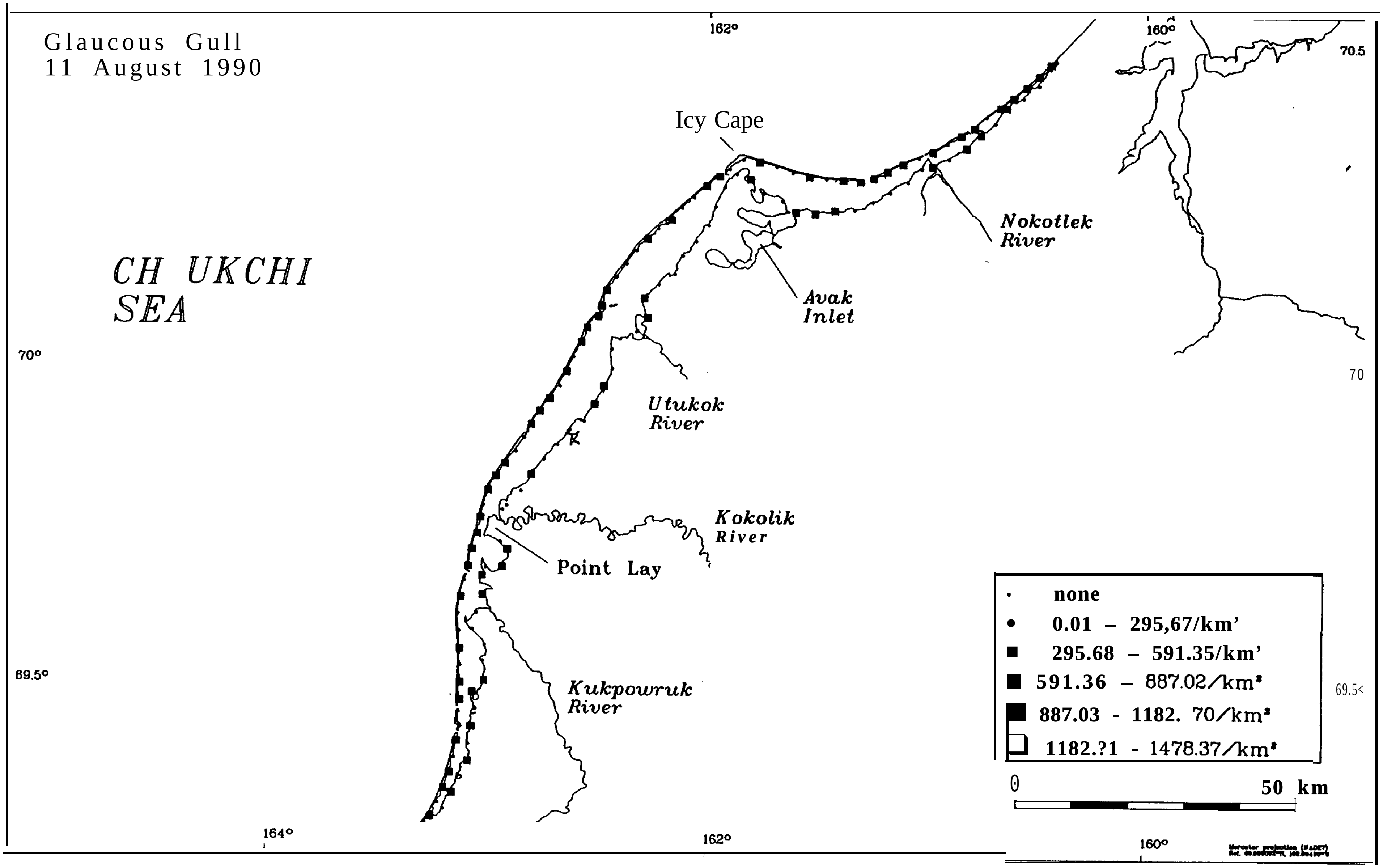

Glaucous Gull
3 September 1989
CHUKCHI
SEA
none
0.01 – 295.67/km²
295.68 – 591.35/km²
591.36 – 887.02/km²
887.03 – 1182.70/km²
1182.71 – 1478.37/km²
0
50 km
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
70°
69.5°
160°

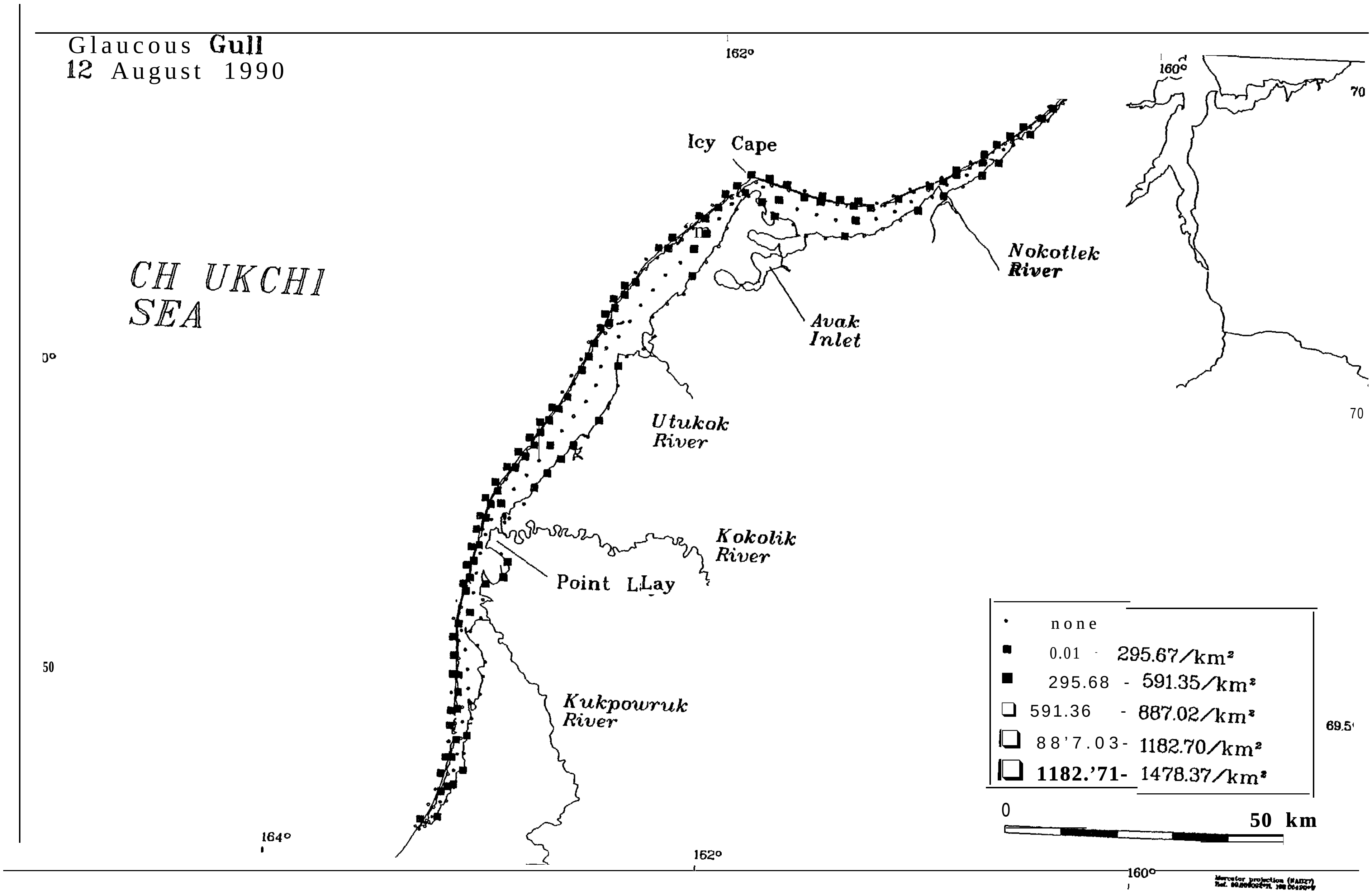

Glaucous Gull
4 September 1989
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
Non-standard calculation (see text)
none
0.01 – 295.67/km²
295.68 – 591.35/km²
591.36 – 887.02/km²
887.03 – 1182.70/km²
1182.71 – 1478.37/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

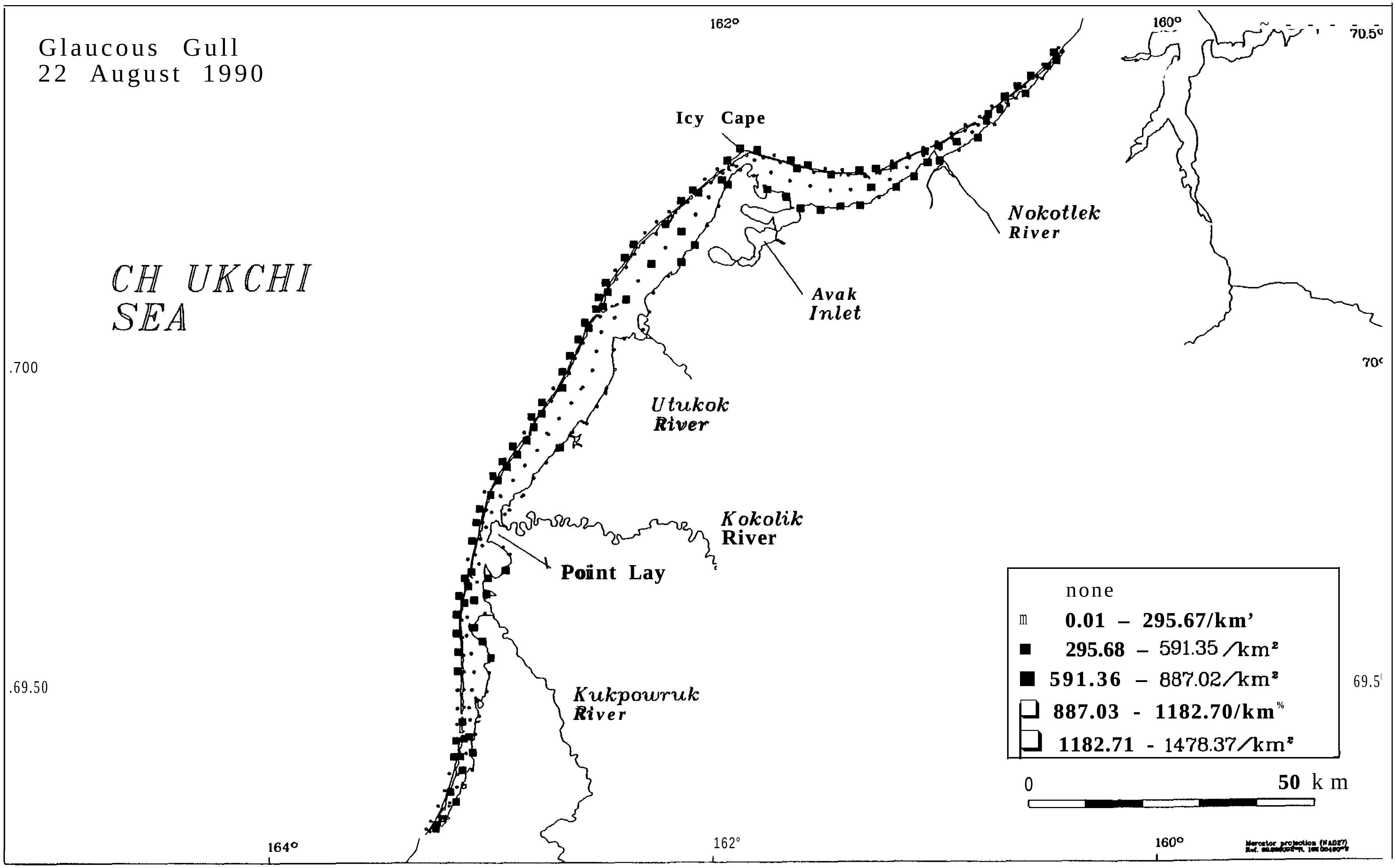

Glaucous Gull
11 September 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 295.67/km²
295.68 - 591.35/km²
591.36 - 887.02/km²
1182.70/km²
1478.37/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°


Glaucous Gull
27 July 1990
Icy Cape
CHUKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
Non-standard calculation (see text)
none
0.01 – 295.67/km²
295.68 – 591.35 Am'
591.36 – 887.02/km²
887.03 - 1182.70/km²
1182.'71 - 1478.37/km²
0
50 km
162°
160°
164°
70°
69.5
.695°
Mercator projection (NAD27)

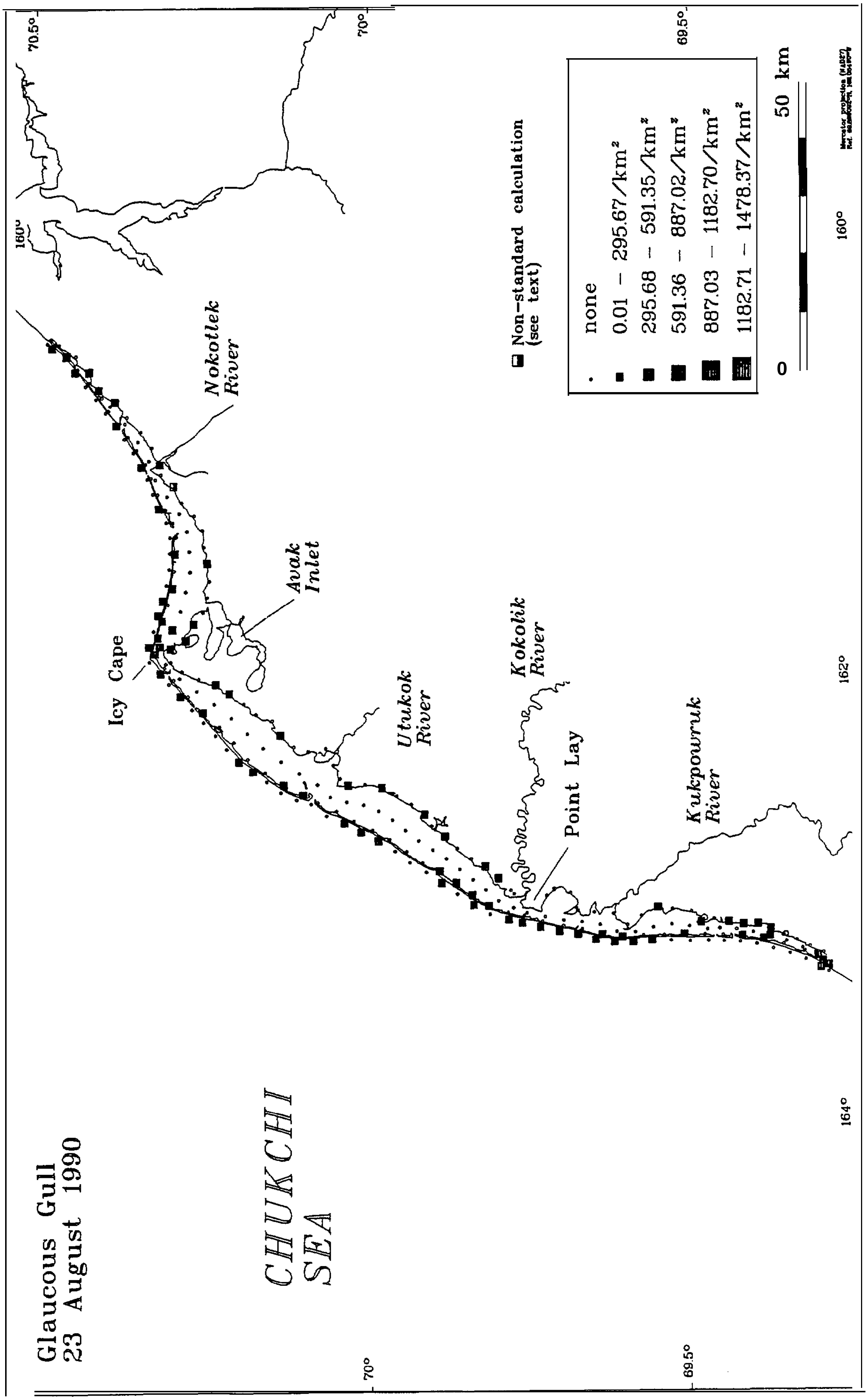

Glaucous Gull
28 July 1990
162°
160°
70.5°
Icy Cape
Nokotlek
River
Avak
Inlet
CH UKCHI
SEA
70°
70°
Utukok
River
Kokolik
River
Point Lay
none
0.01 – 295.67/km'
295.68 – 591.35/km'
591.36 – 887.02/km²
887.03 - 1182.70/km²
1182.71- 1478.37/km²
0
50 km
69.5°
69.5
Kukpowruk
River
164°
162°
160°

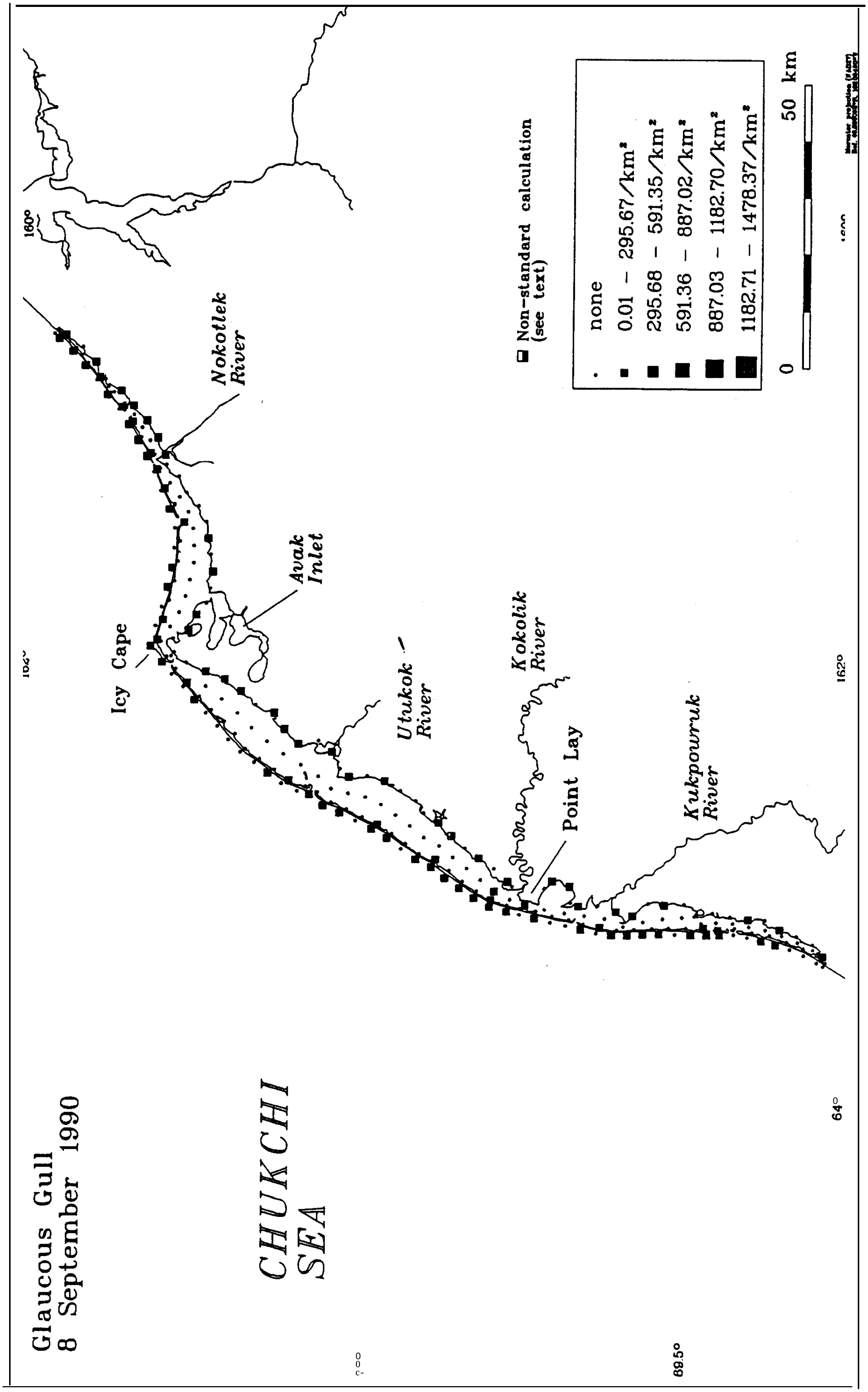

Glaucous Gull
11 August 1990
162°
160°
70.5
Icy Cape
CH UKCHI SEA
Nokotlek River
Avak Inlet
70°
70
Utukok River
Kokolik River
Point Lay
69.5°
69.5<
Kukpowruk River
none
0.01 – 295,67/km’
295.68 – 591.35/km’
591.36 – 887.02/km²
887.03 - 1182. 70/km²
1182.?1 - 1478.37/km²
0
50 km
164°
162°
160°

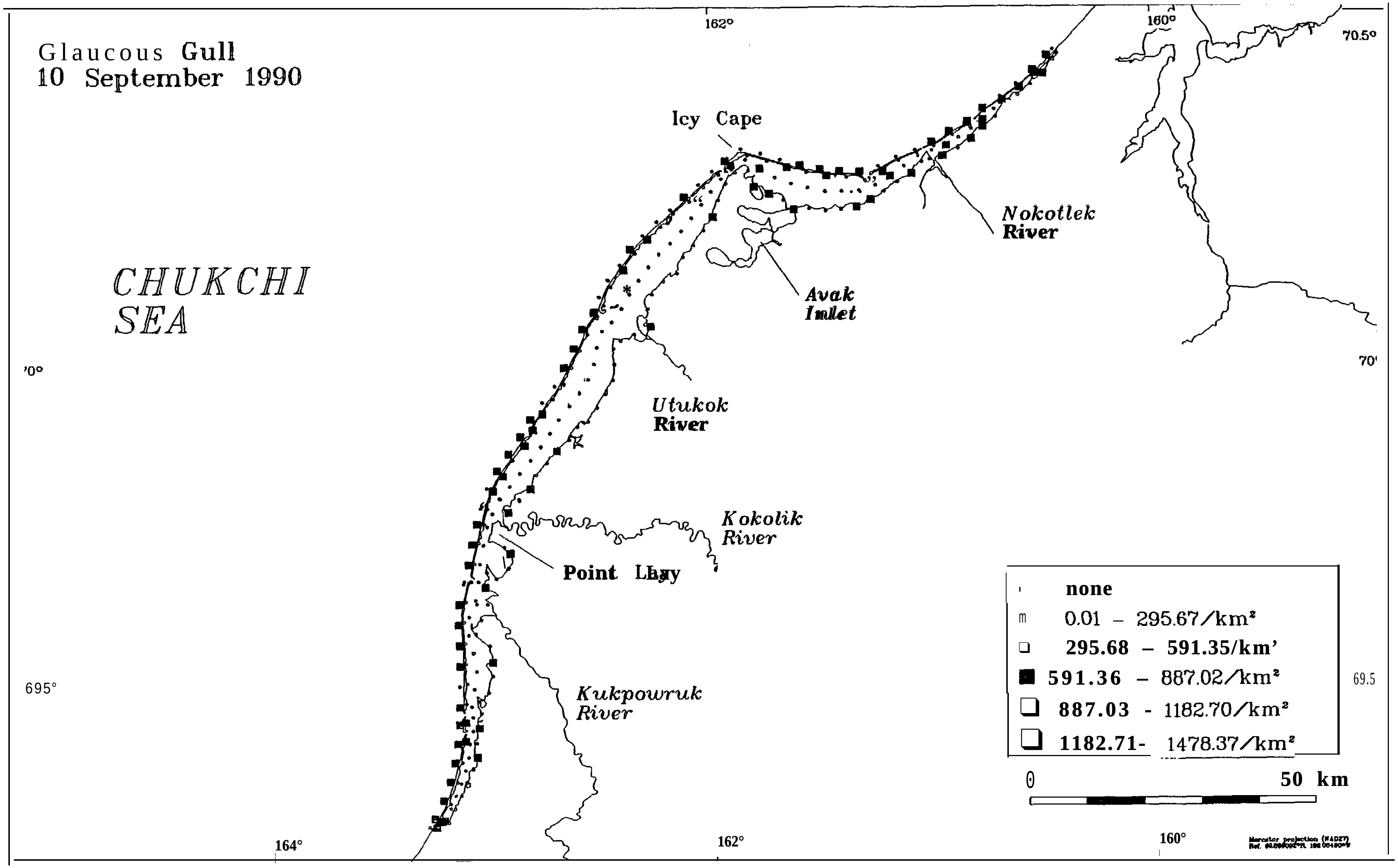

Glaucous Gull
12 August 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70
69.5
50
none
0.01 - 295.67/km²
295.68 - 591.35/km²
591.36 - 887.02/km²
887.03 - 1182.70/km²
1182.71 - 1478.37/km²
0
50 km
Mercator projection (NAD27)

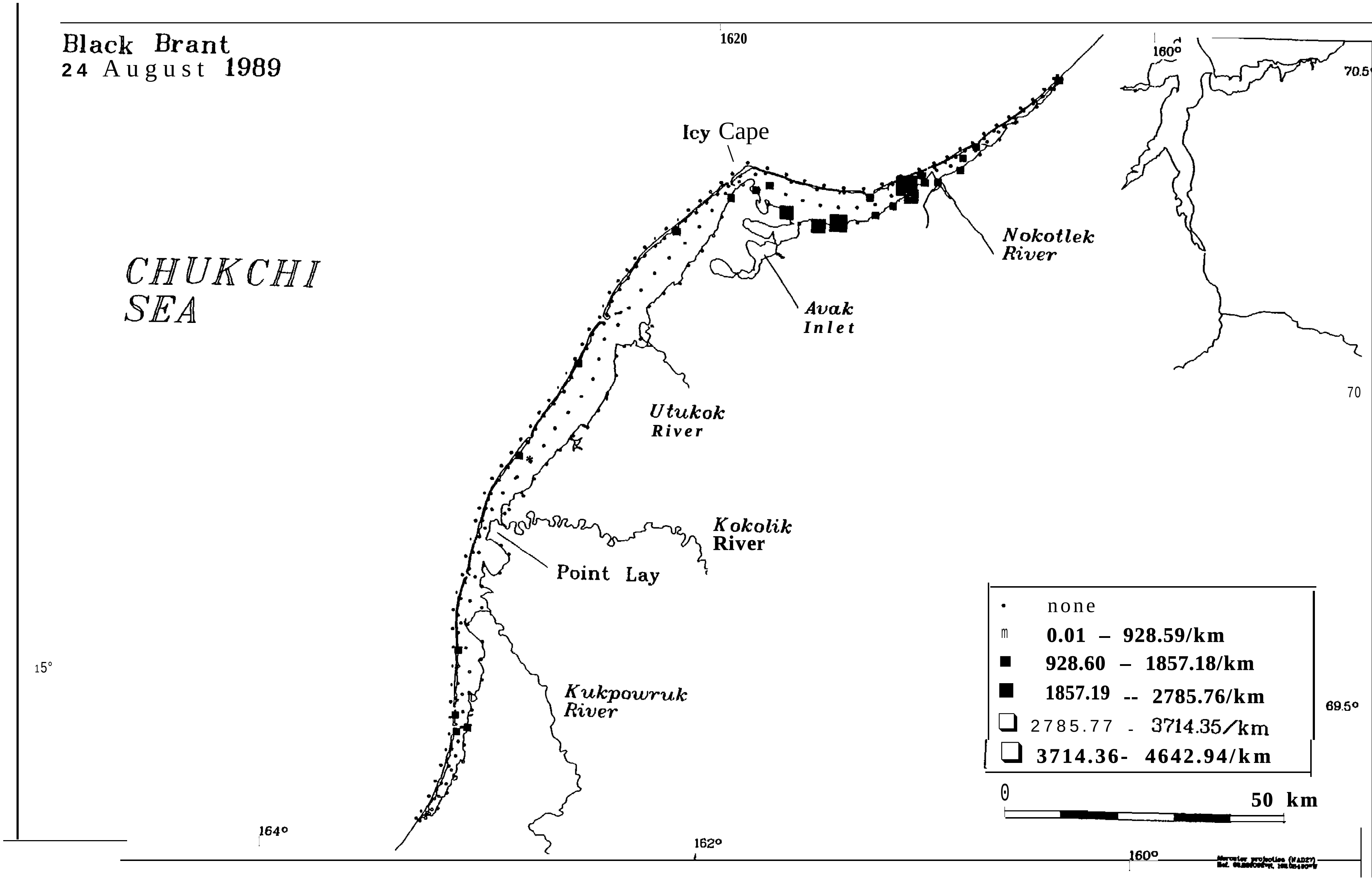


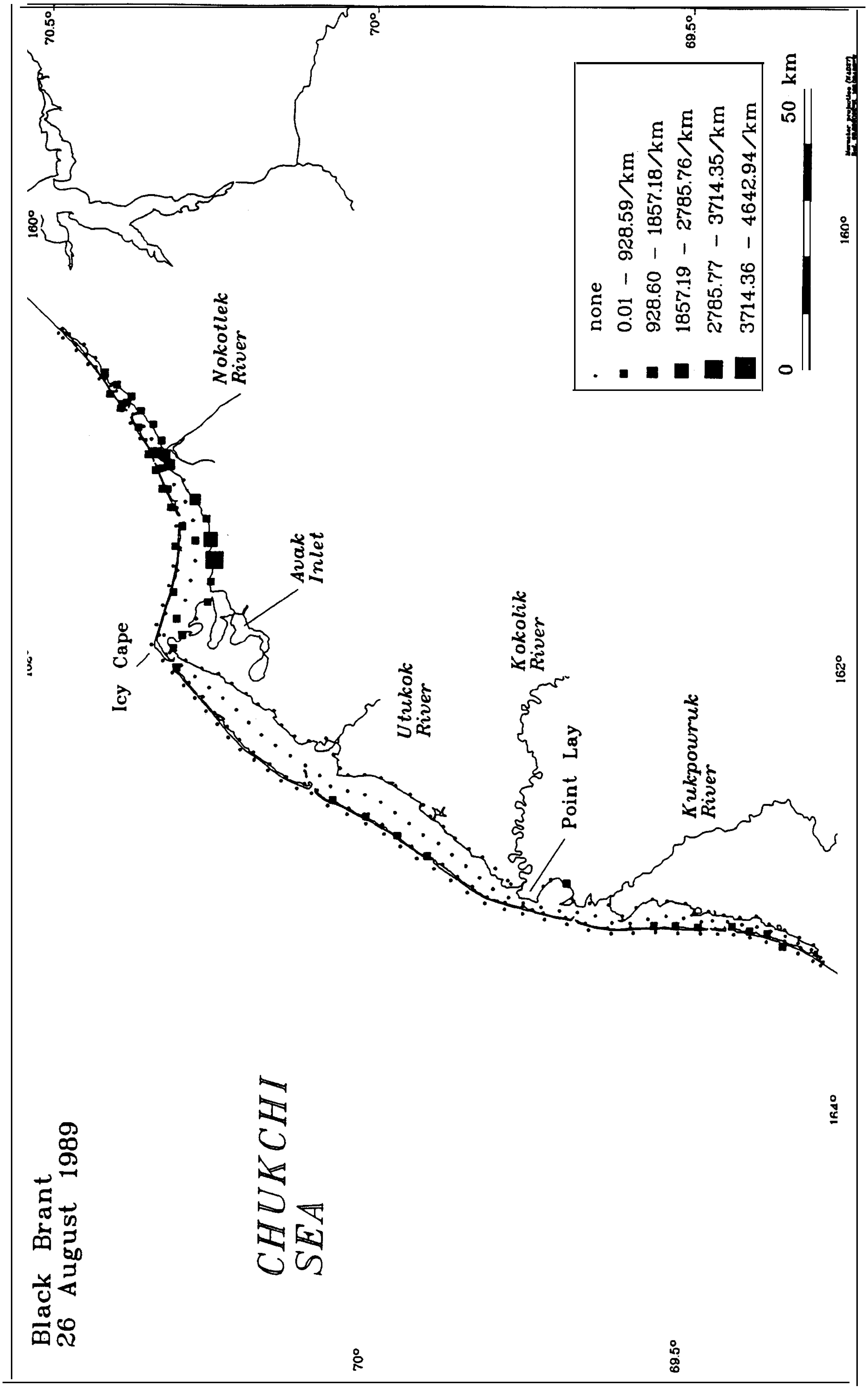
Glaucous Gull
22 August 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70.5°
70°
69.5°
.700
.69.50
none
0.01 – 295.67/km²
295.68 – 591.35/km²
591.36 – 887.02/km²
887.03 - 1182.70/km²
1182.71 - 1478.37/km²
0
50 km
Mercator projection (NAD27)


Glaucous Gull
23 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
Non-standard calculation
(see text)
none
0.01 – 295.67/km²
295.68 – 591.35/km²
591.36 – 887.02/km²
887.03 – 1182.70/km²
1182.71 – 1478.37/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

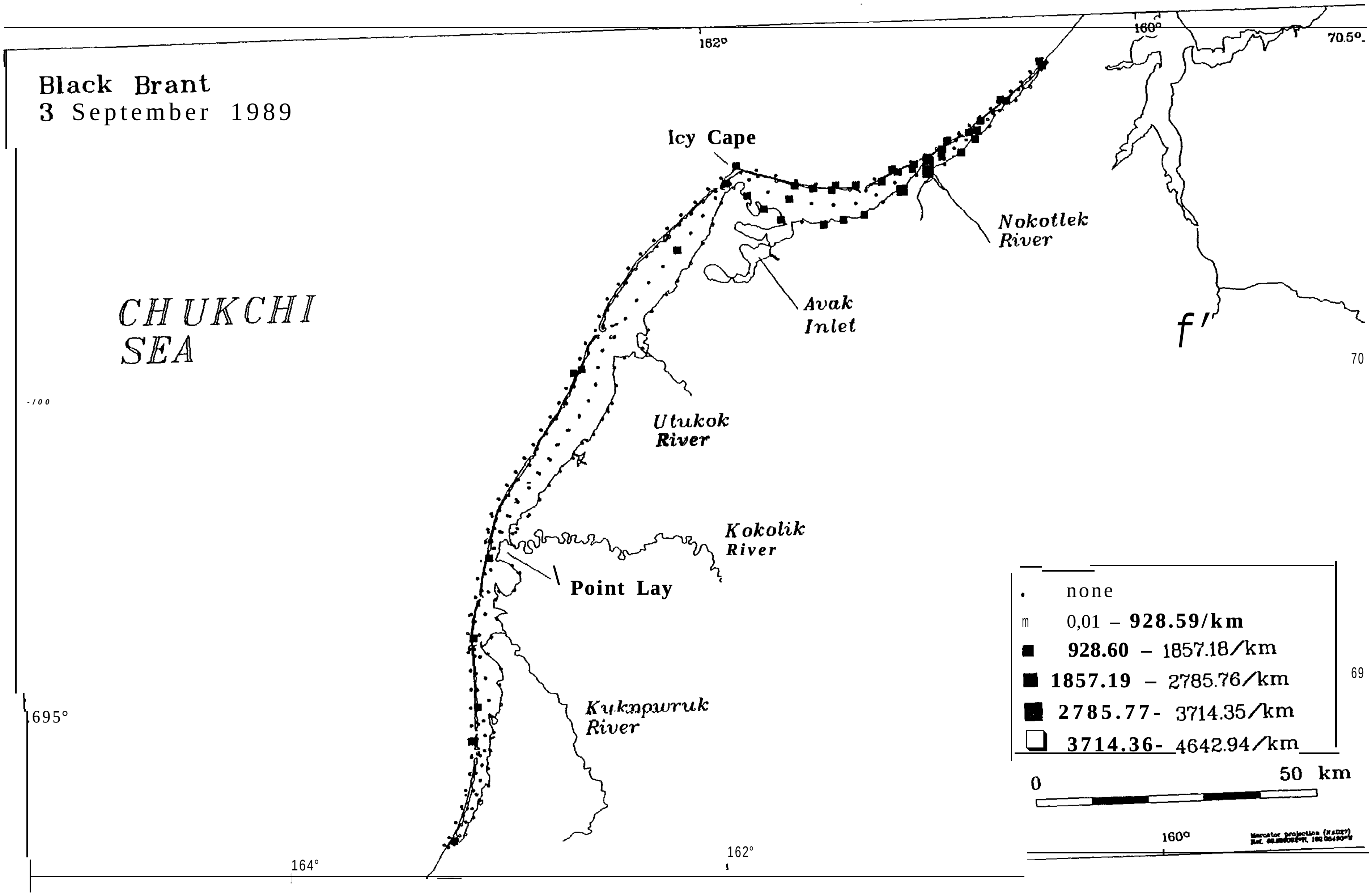

Glaucous Gull
8 September 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
Non-standard calculation
(see text)
none
0.01 - 295.67/km²
295.68 - 591.35/km²
591.36 - 887.02/km²
887.03 - 1182.70/km²
1182.71 - 1478.37/km²
0
50 km
160°
162°
64°
69.5°

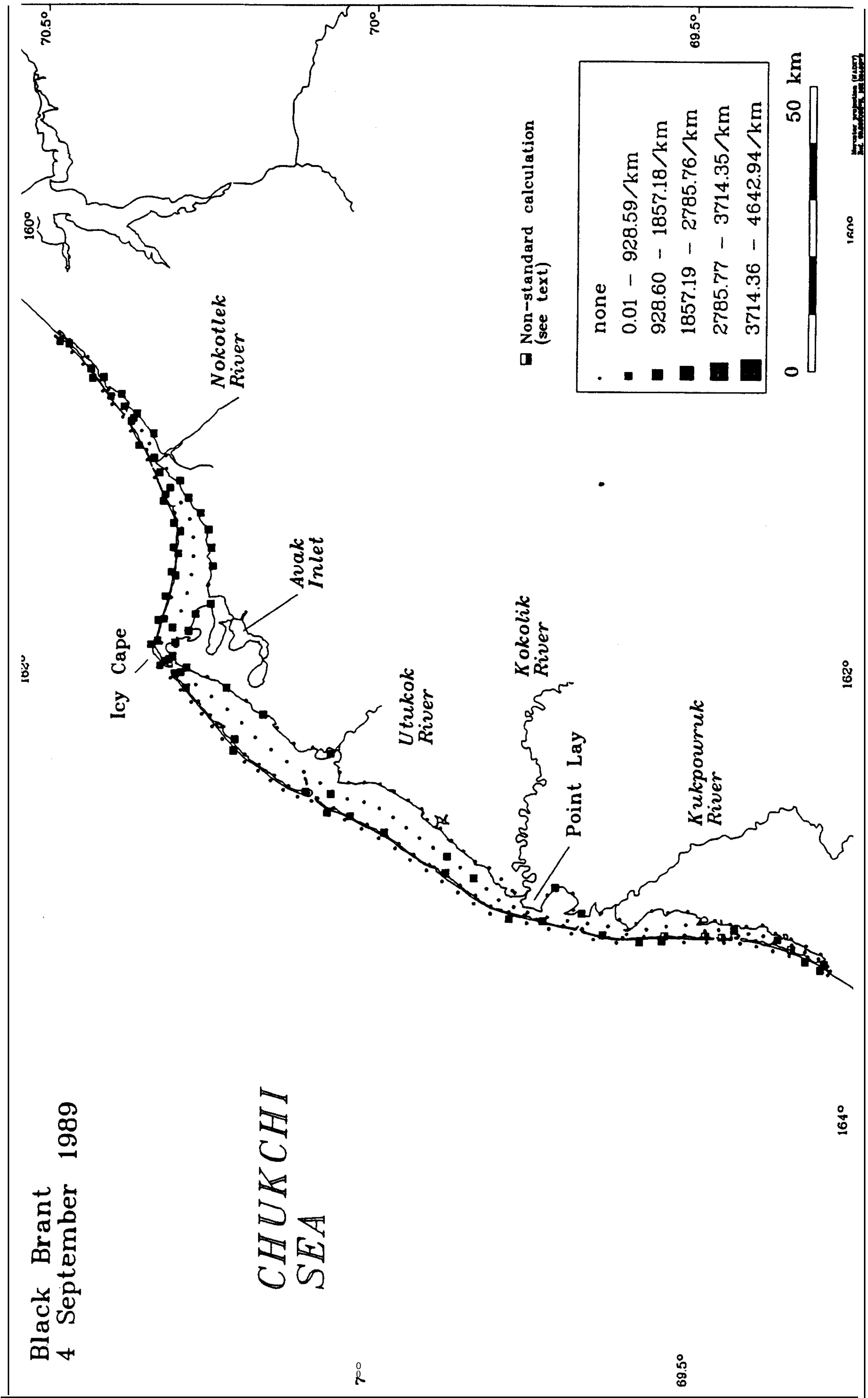

Glaucous Gull
10 September 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
160°
70.5°
70°
69.5
695°
164°
none
0.01 – 295.67/km²
295.68 – 591.35/km²
591.36 – 887.02/km²
887.03 - 1182.70/km²
1182.71- 1478.37/km²
0
50 km


Black Brant
24 August 1989
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
1620
160°
70.5
70
69.5°
15°
164°
162°
160°
• none
m 0.01 – 928.59/km
928.60 – 1857.18/km
1857.19 -- 2785.76/km
2785.77 - 3714.35/km
3714.36- 4642.94/km
0
50 km

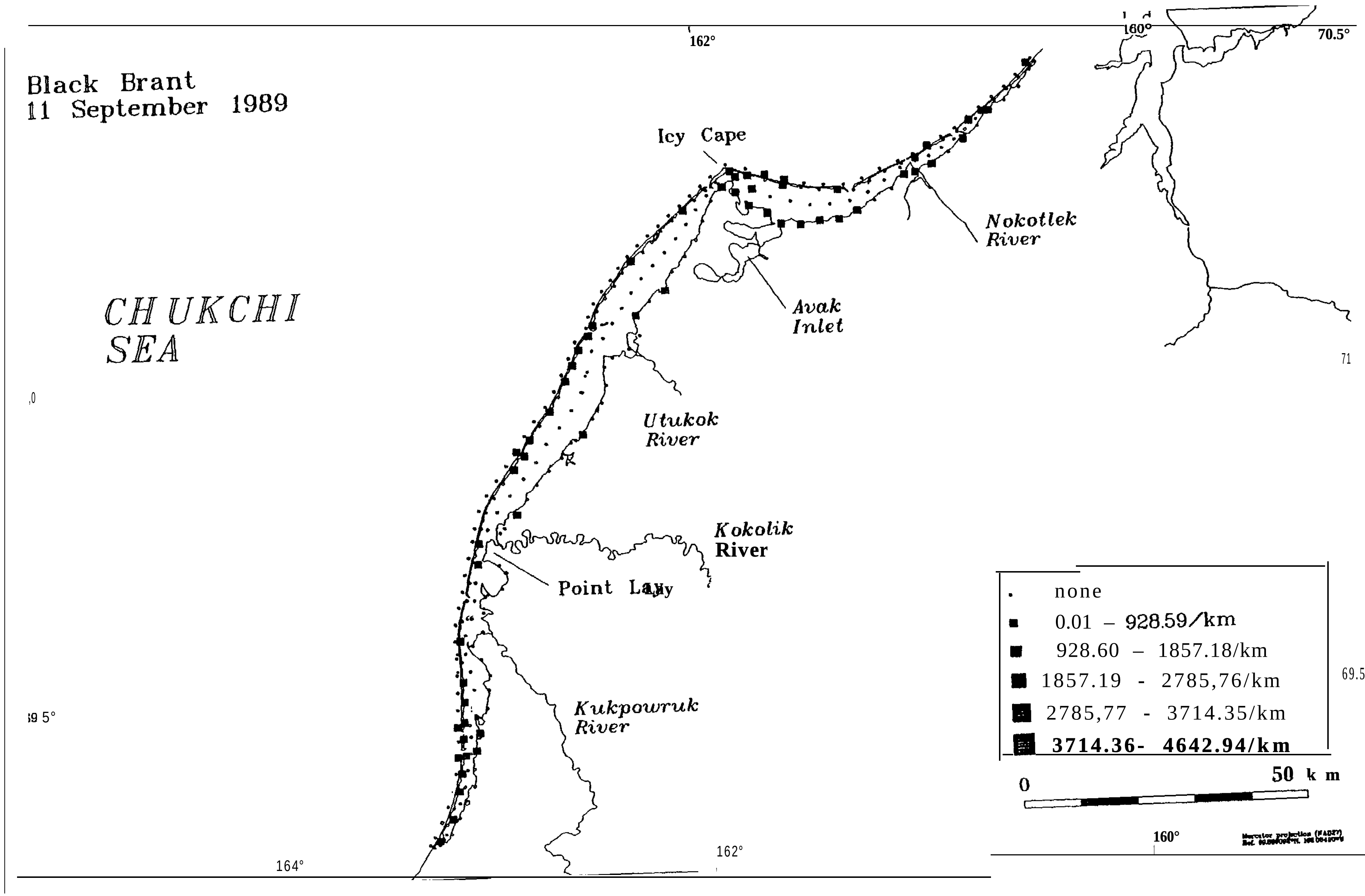


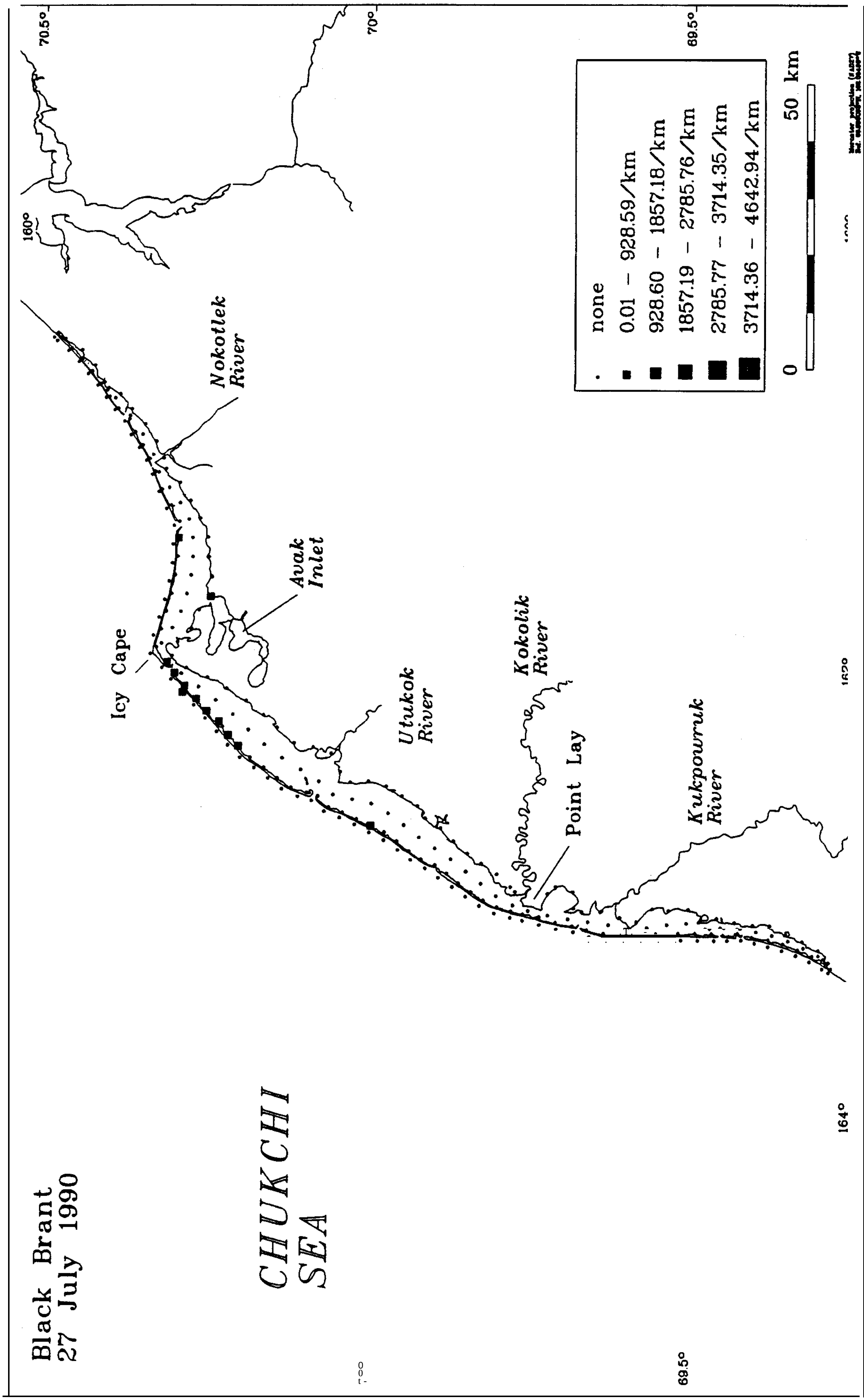
Black Brant
26 August 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 928.59/km
928.60 - 1857.18/km
1857.19 - 2785.76/km
2785.77 - 3714.35/km
3714.36 - 4642.94/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

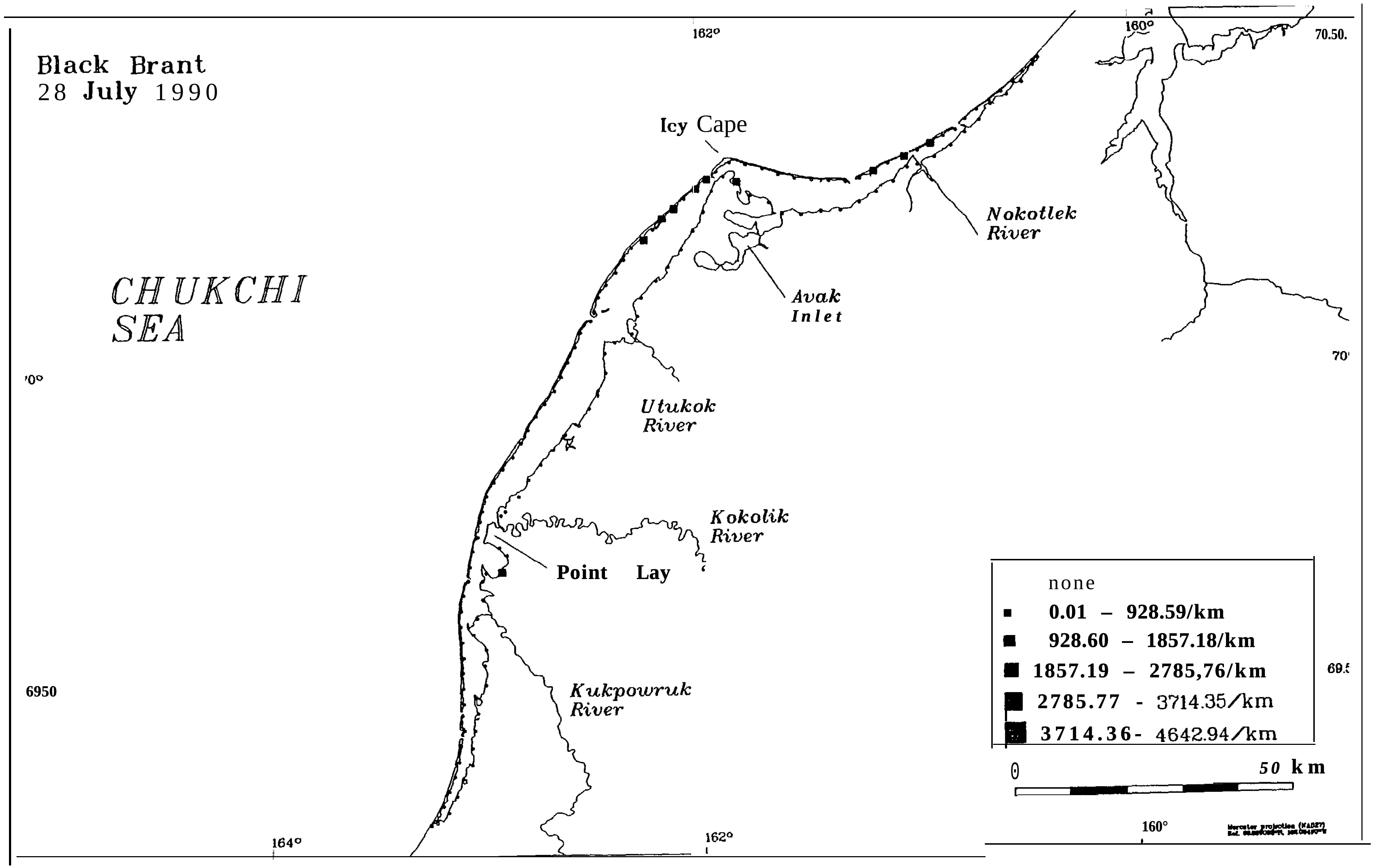

Black Brant
3 September 1989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
160°
70.5°
70
69
1695°
164°
162°
160°
none
0,01 – 928.59/km
928.60 – 1857.18/km
1857.19 – 2785.76/km
2785.77- 3714.35/km
3714.36- 4642.94/km
0
50 km

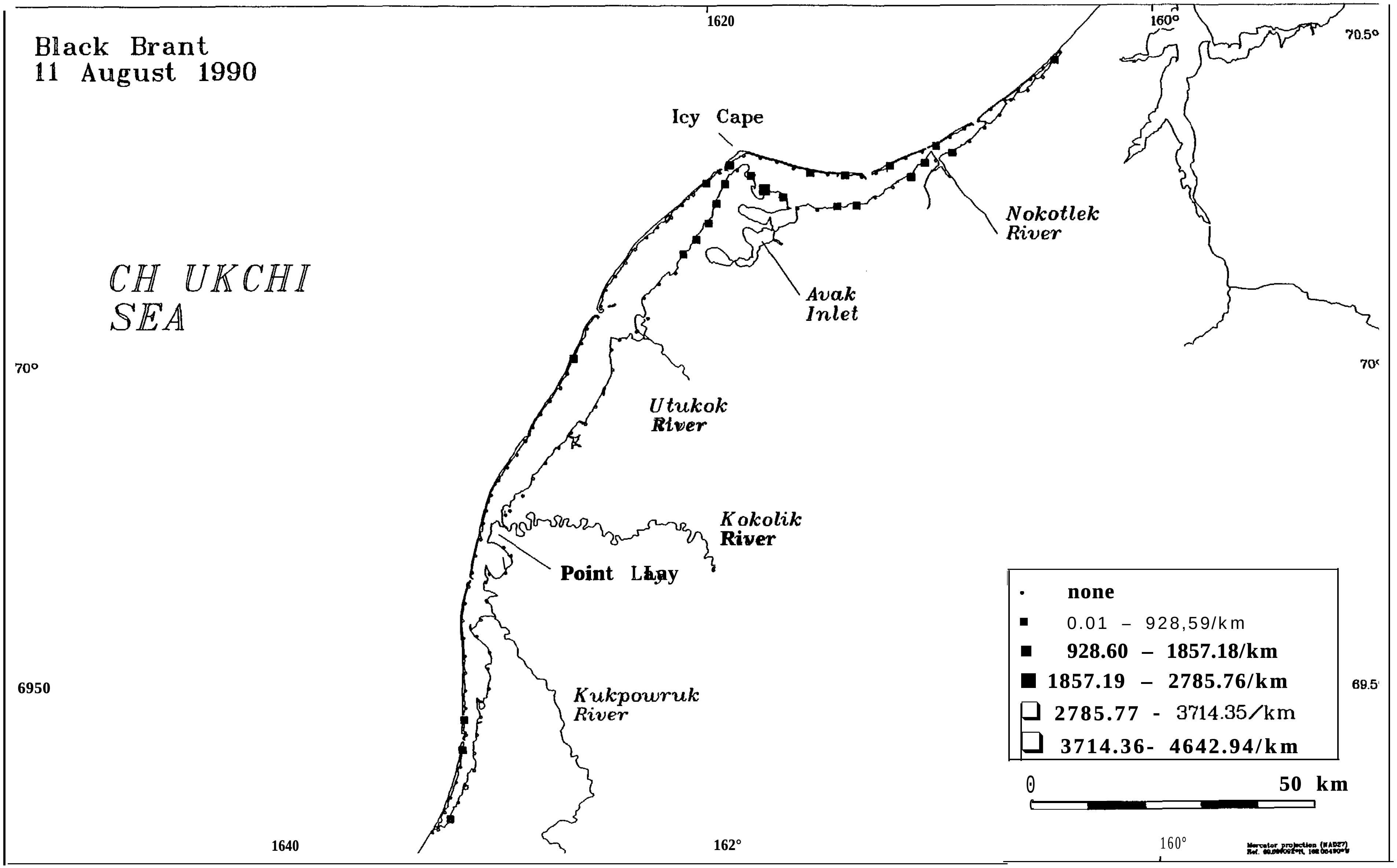


Black Brant
4 September 1989
CHUKCHI
SEA
Icy Cape
Avak Inlet
Nokotlek River
Utukok River
Kokolik River
Point Lay
Kukpowruk River
Non-standard calculation (see text)
none
0.01 - 928.59/km
928.60 - 1857.18/km
1857.19 - 2785.76/km
2785.77 - 3714.35/km
3714.36 - 4642.94/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

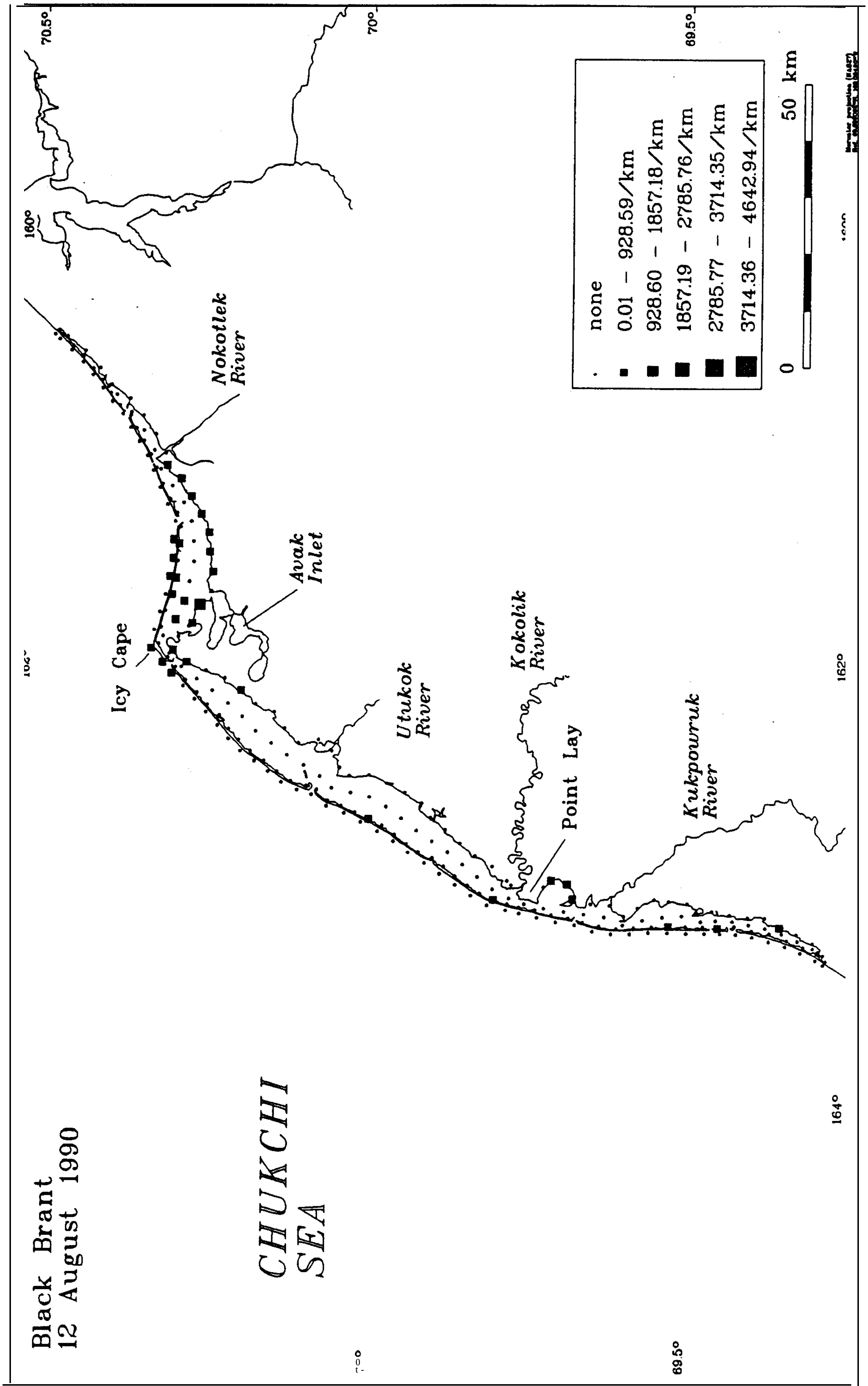

Black Brant
11 September 1989
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 928.59/km
928.60 – 1857.18/km
1857.19 - 2785,76/km
2785,77 - 3714.35/km
3714.36- 4642.94/km
0
50 km
162°
160°
70.5°
71
69.5
164°

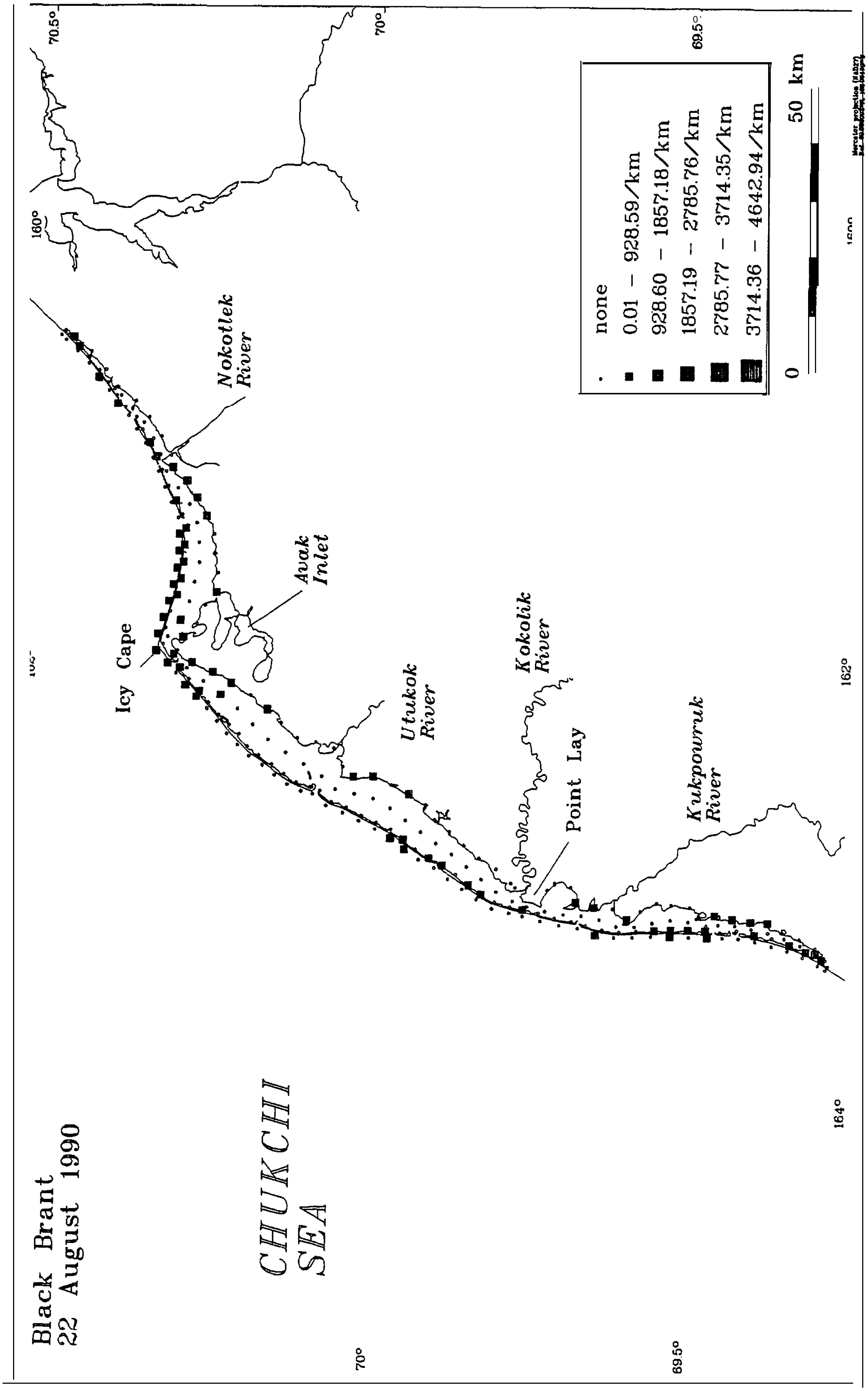

Black Brant
27 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 928.59/km
928.60 – 1857.18/km
1857.19 – 2785.76/km
2785.77 – 3714.35/km
3714.36 – 4642.94/km
0
50 km
70.5°
70°
69.5°
160°
164°
69.5°

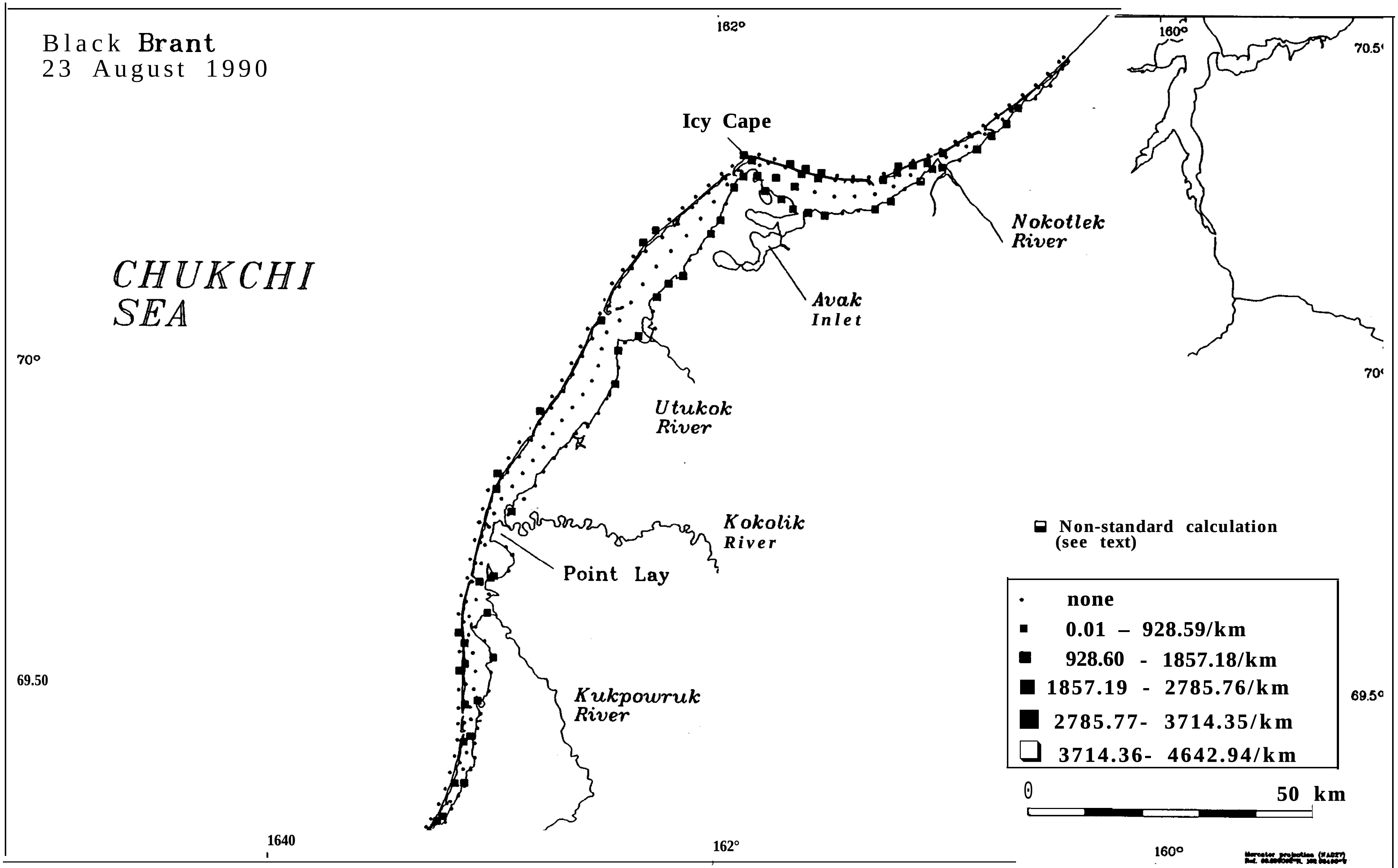

Black Brant
28 July 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70.50.
70'
'0°
69.5
6950
none
0.01 – 928.59/km
928.60 – 1857.18/km
1857.19 – 2785,76/km
2785.77 - 3714.35/km
3714.36- 4642.94/km
0
50 km

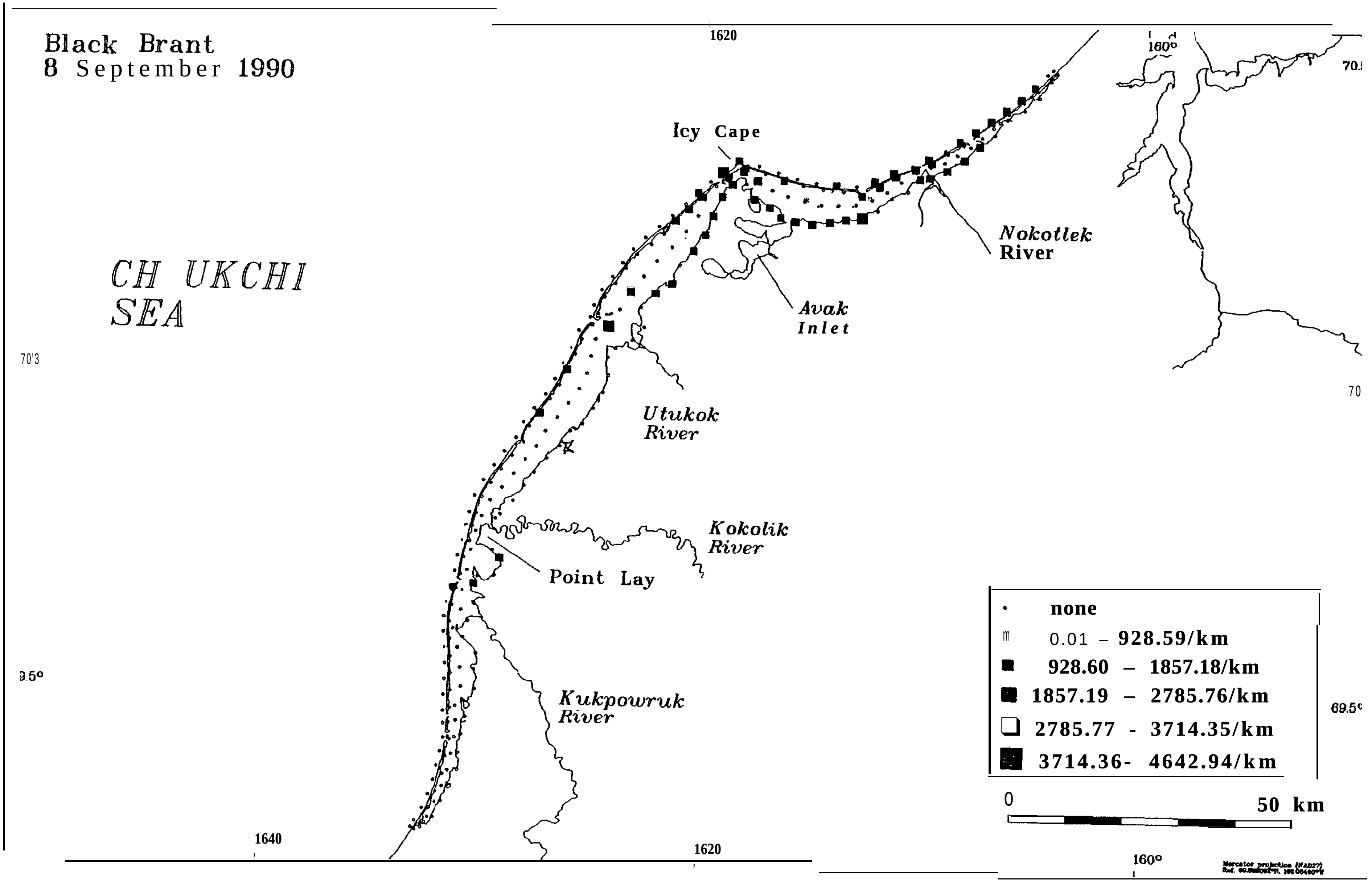


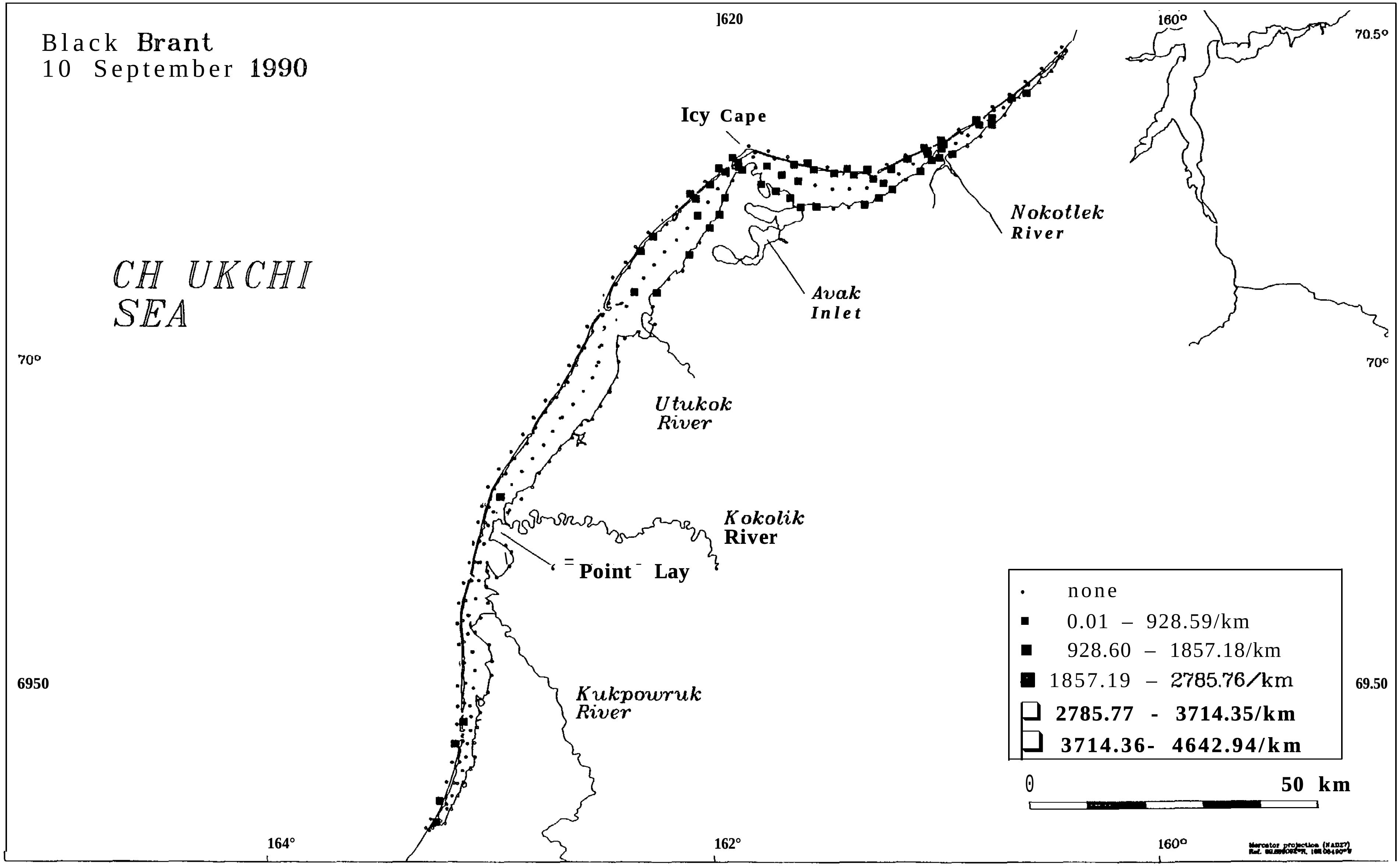
Black Brant
11 August 1990
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
1620
160°
70.5°
70°
6950
69.5°
1640
162°
160°
none
0.01 – 928,59/km
928.60 – 1857.18/km
1857.19 – 2785.76/km
2785.77 - 3714.35/km
3714.36- 4642.94/km
0
50 km
Mercator projection (NAD27)


Black Brant
12 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 928.59/km
928.60 – 1857.18/km
1857.19 – 2785.76/km
2785.77 – 3714.35/km
3714.36 – 4642.94/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°
69.5°

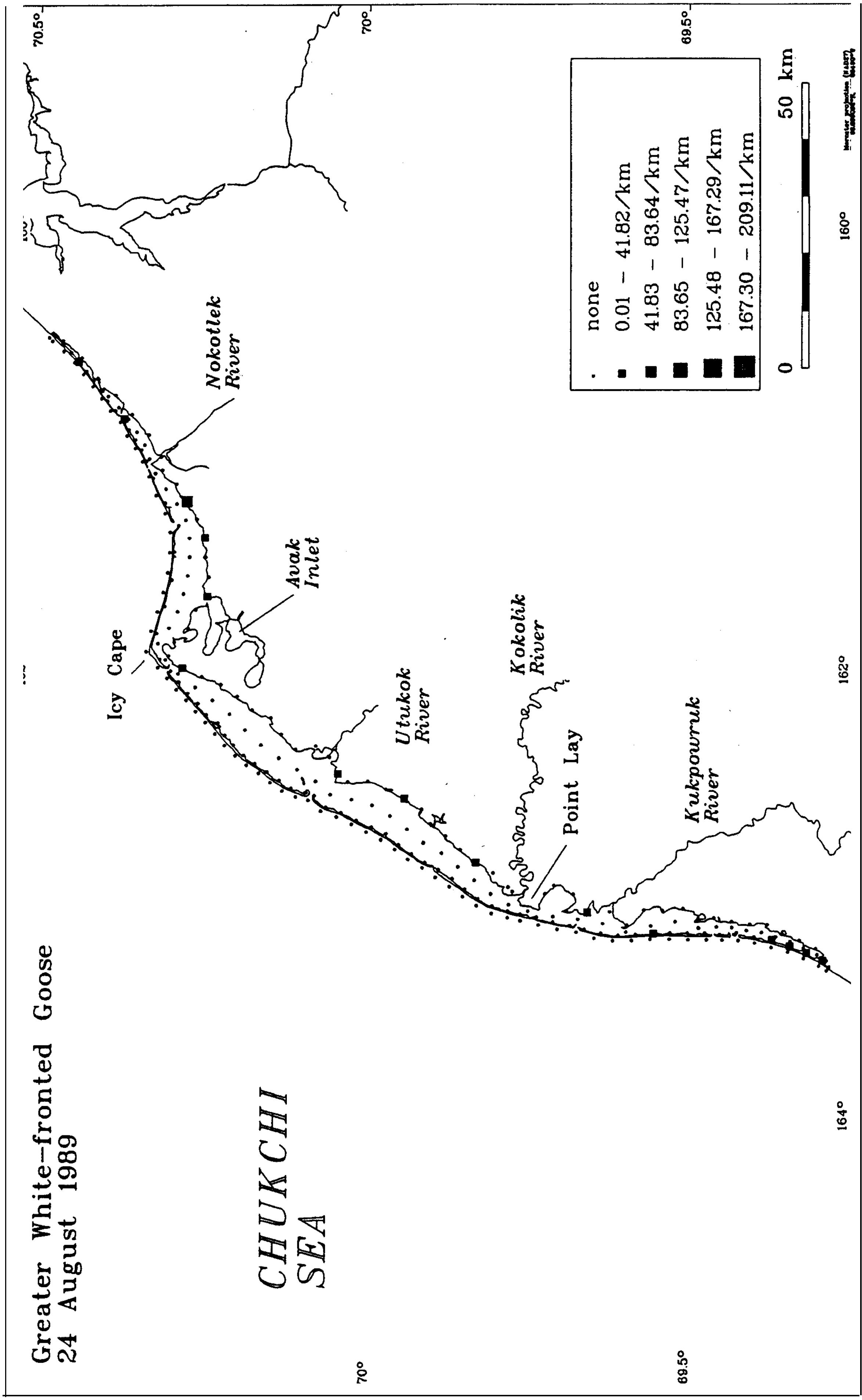

Black Brant
22 August 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 928.59/km
928.60 - 1857.18/km
1857.19 - 2785.76/km
2785.77 - 3714.35/km
3714.36 - 4642.94/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

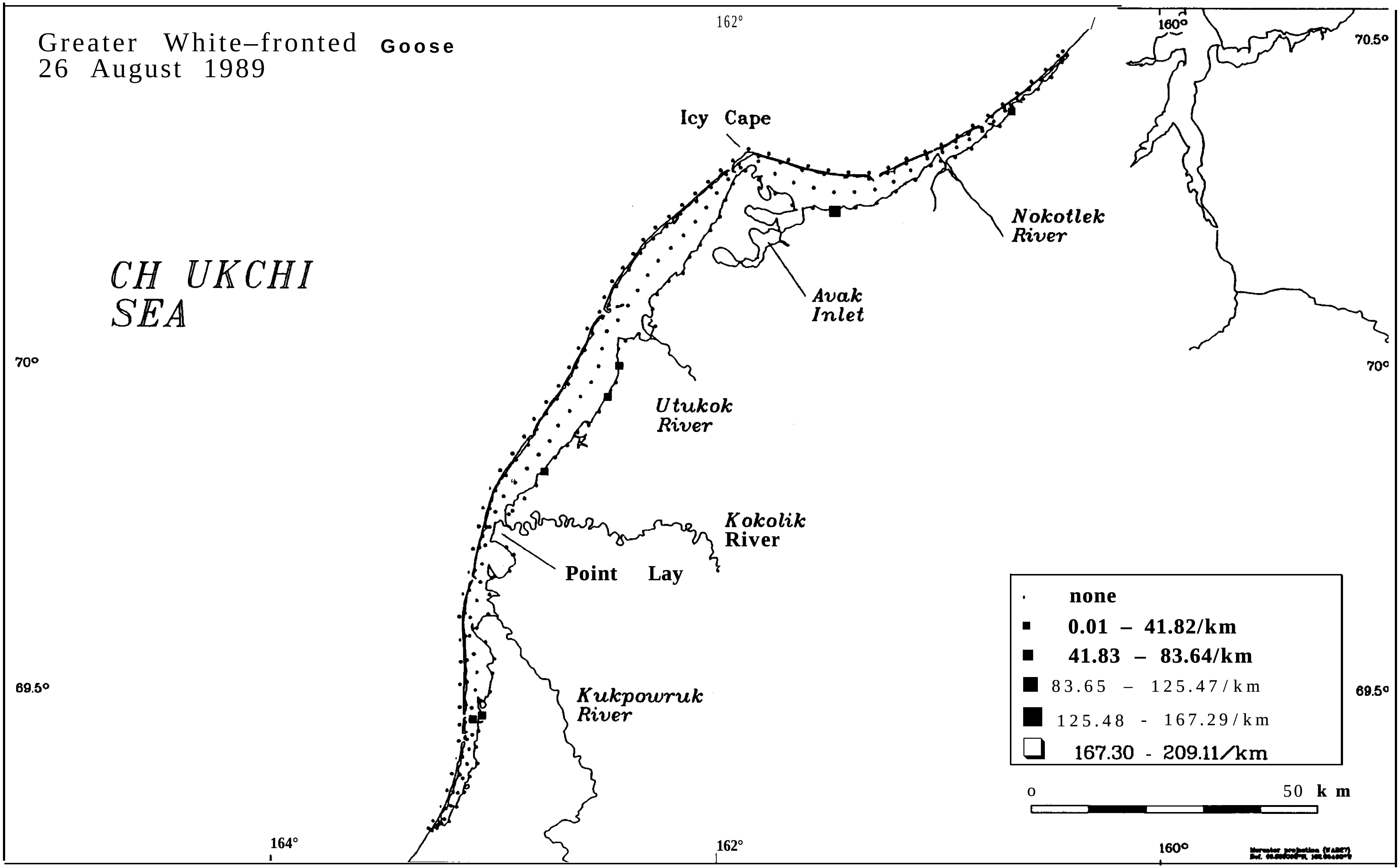

Black Brant
23 August 1990
162°
160°
70.5°
Icy Cape
Nokotlek River
Avak Inlet
CHUKCHI SEA
70°
70°
Utukok River
Kokolik River
Point Lay
Non-standard calculation (see text)
none
0.01 – 928.59/km
928.60 - 1857.18/km
1857.19 - 2785.76/km
2785.77- 3714.35/km
3714.36- 4642.94/km
0
50 km
69.50
69.5°
Kukpowruk River
1640
162°
160°

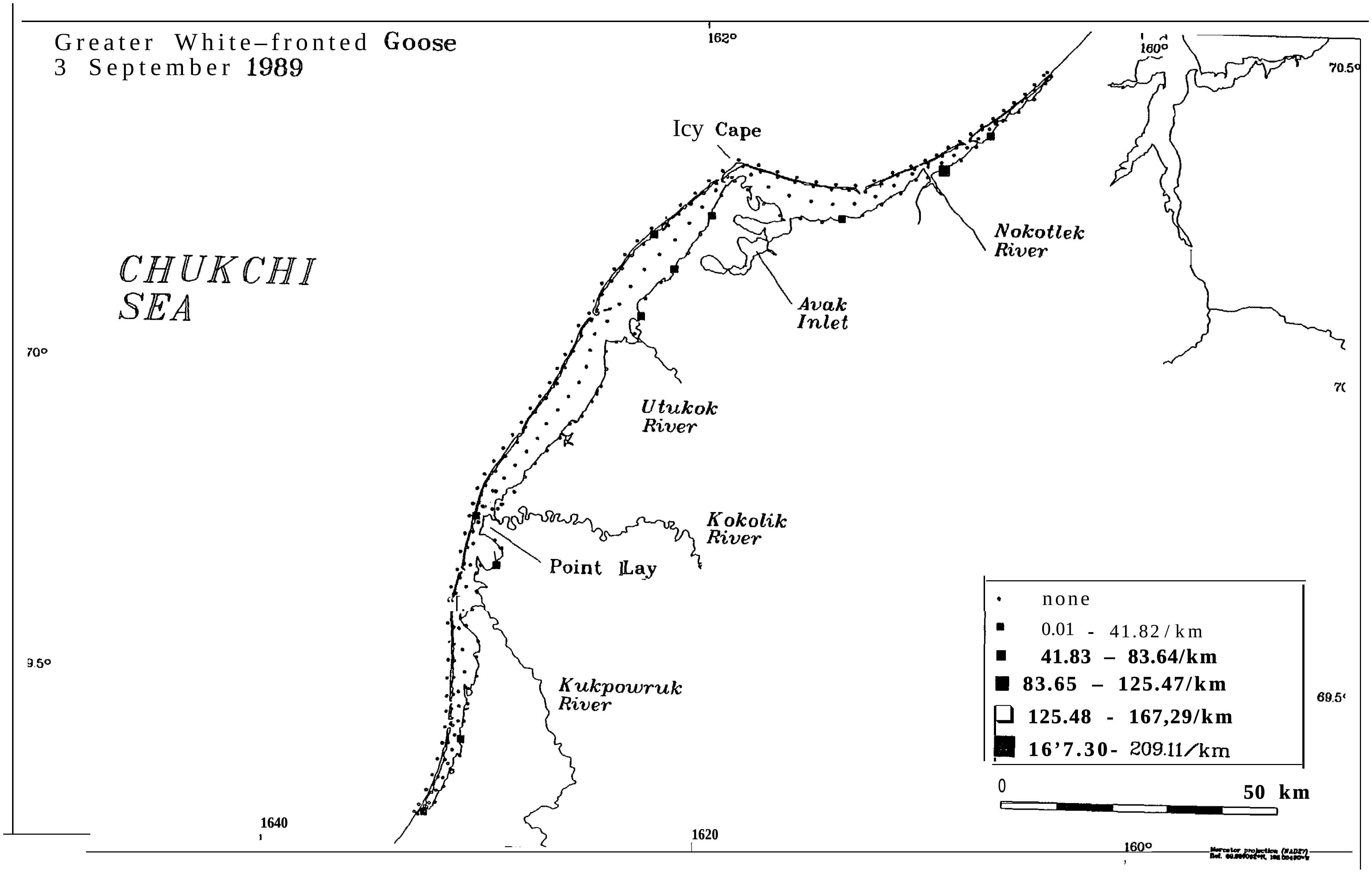

Black Brant
8 September 1990
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
1620
160°
70.
70'3
70
9.5°
69.5°
1640
1620
160°
none
0.01 – 928.59/km
928.60 – 1857.18/km
1857.19 – 2785.76/km
2785.77 - 3714.35/km
3714.36- 4642.94/km
0
50 km
Mercator projection (NAD27)

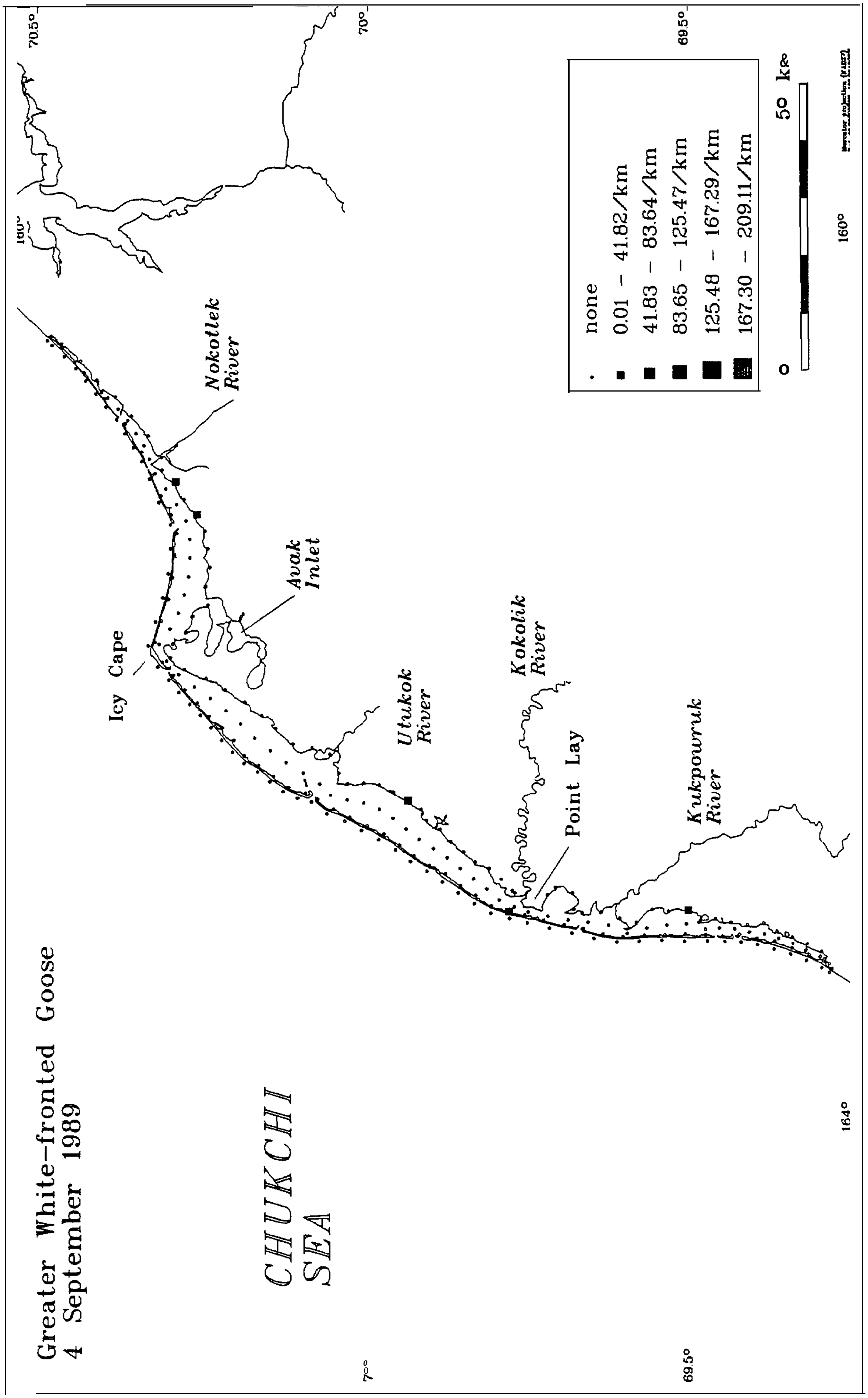


Black Brant
10 September 1990
]620
160°
70.5°
Icy Cape
Nokotlek
River
Avak
Inlet
CH UKCHI
SEA
70°
70°
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 928.59/km
928.60 – 1857.18/km
1857.19 – 2785.76/km
2785.77 - 3714.35/km
3714.36- 4642.94/km
0
50 km
6950
69.50
164°
162°
160°

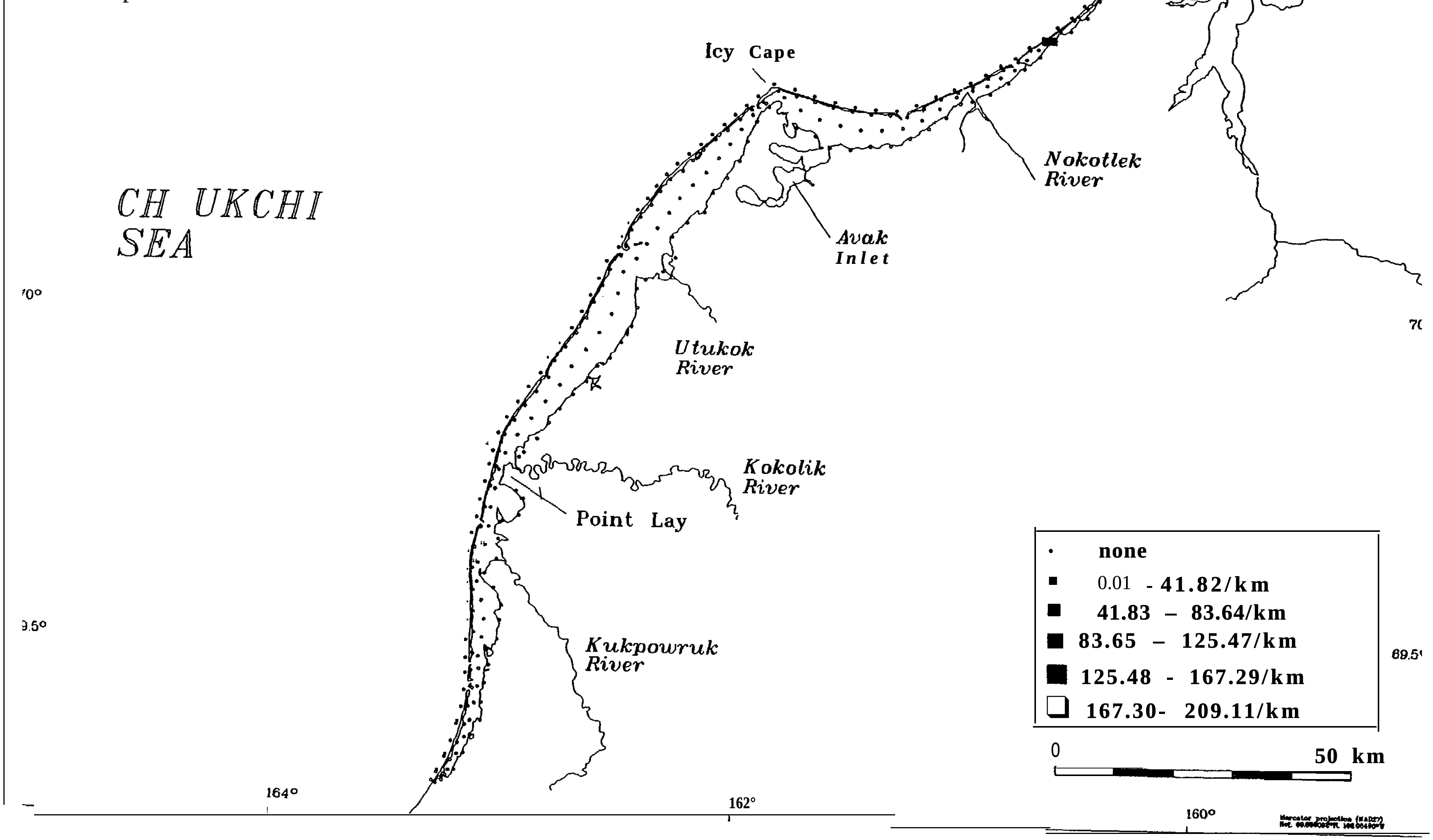

Greater White-fronted Goose
24 August 1989
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 41.82/km
41.83 - 83.64/km
83.65 - 125.47/km
125.48 - 167.29/km
167.30 - 209.11/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

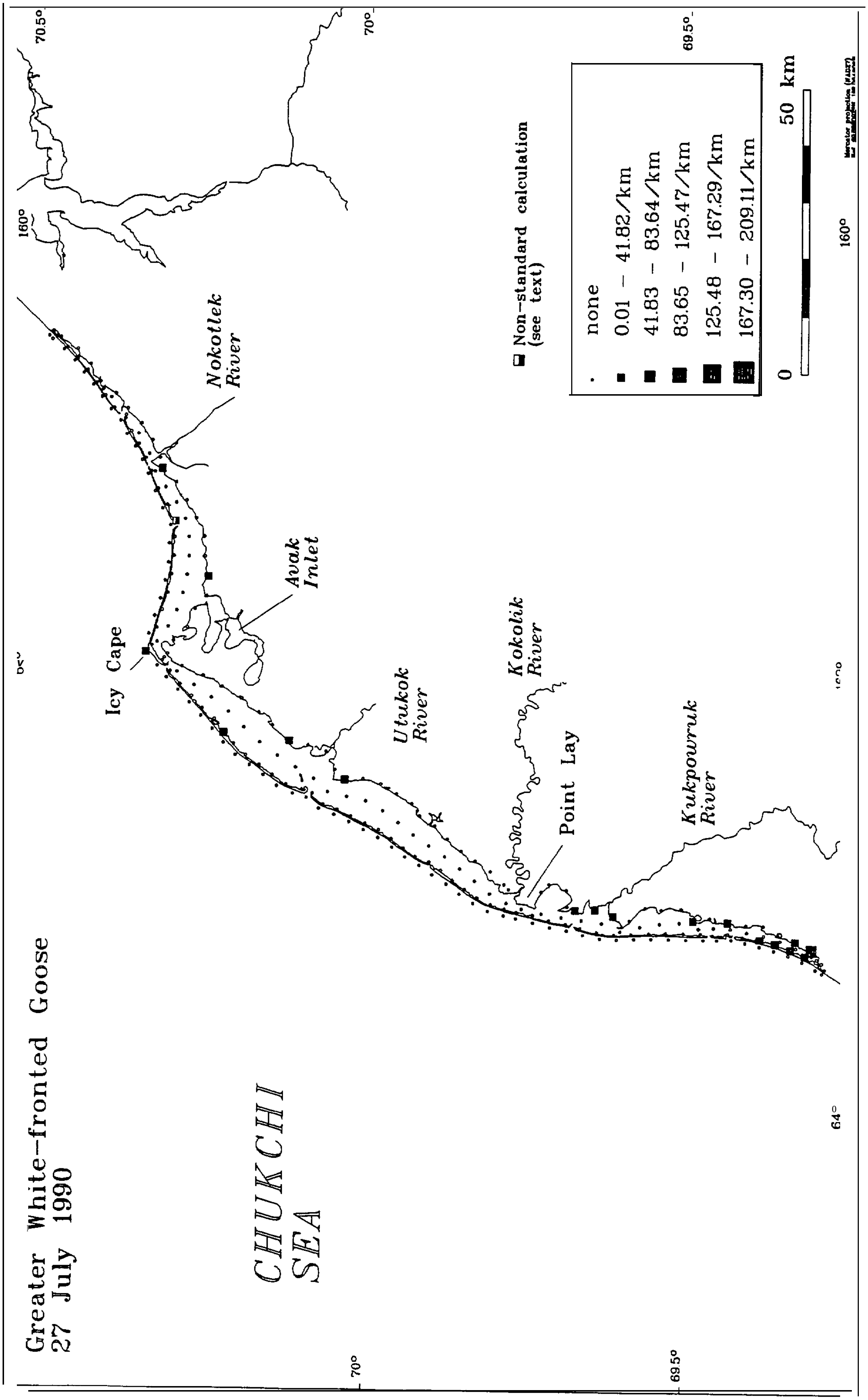

Greater White–fronted Goose
26 August 1989
162°
160°
70.5°
Icy Cape
Nokotlek River
Avak Inlet
CH UKCHI SEA
70°
70°
Utukok River
Kokolik River
Point Lay
69.5°
69.5°
Kukpowruk River
164°
162°
160°
none
0.01 – 41.82/km
41.83 – 83.64/km
83.65 – 125.47/km
125.48 - 167.29/km
167.30 - 209.11/km
0
50 km


Greater White-fronted Goose
3 September 1989
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
69.5°
1640
1620
none
0.01 - 41.82/km
41.83 – 83.64/km
83.65 – 125.47/km
125.48 - 167,29/km
16'7.30- 209.11/km
0
50 km

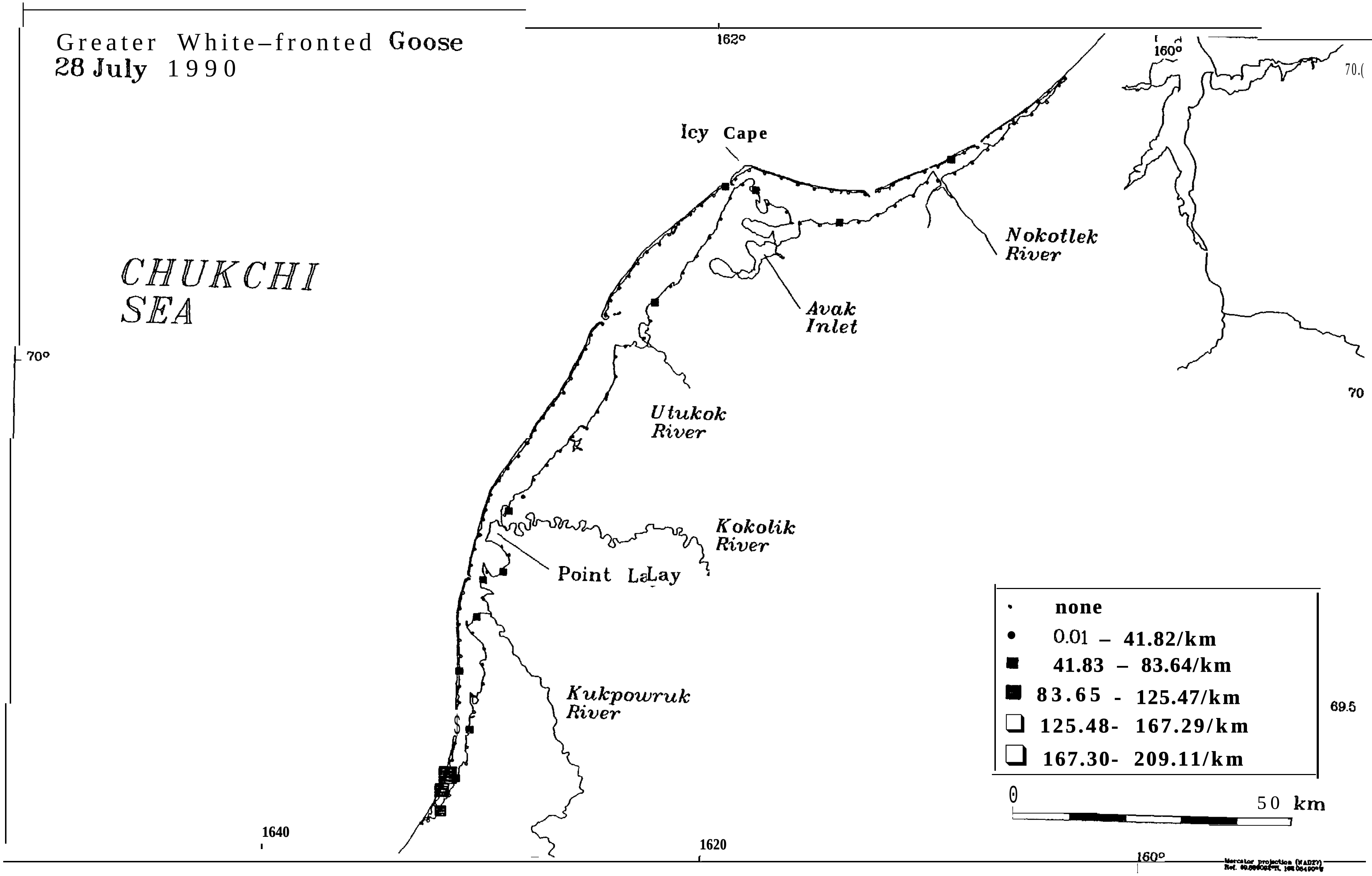

Greater White-fronted Goose
4 September 1989
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 41.82/km
41.83 - 83.64/km
83.65 - 125.47/km
125.48 - 167.29/km
167.30 - 209.11/km
0
50 km
70.5°
70°
69.5°
160°
164°

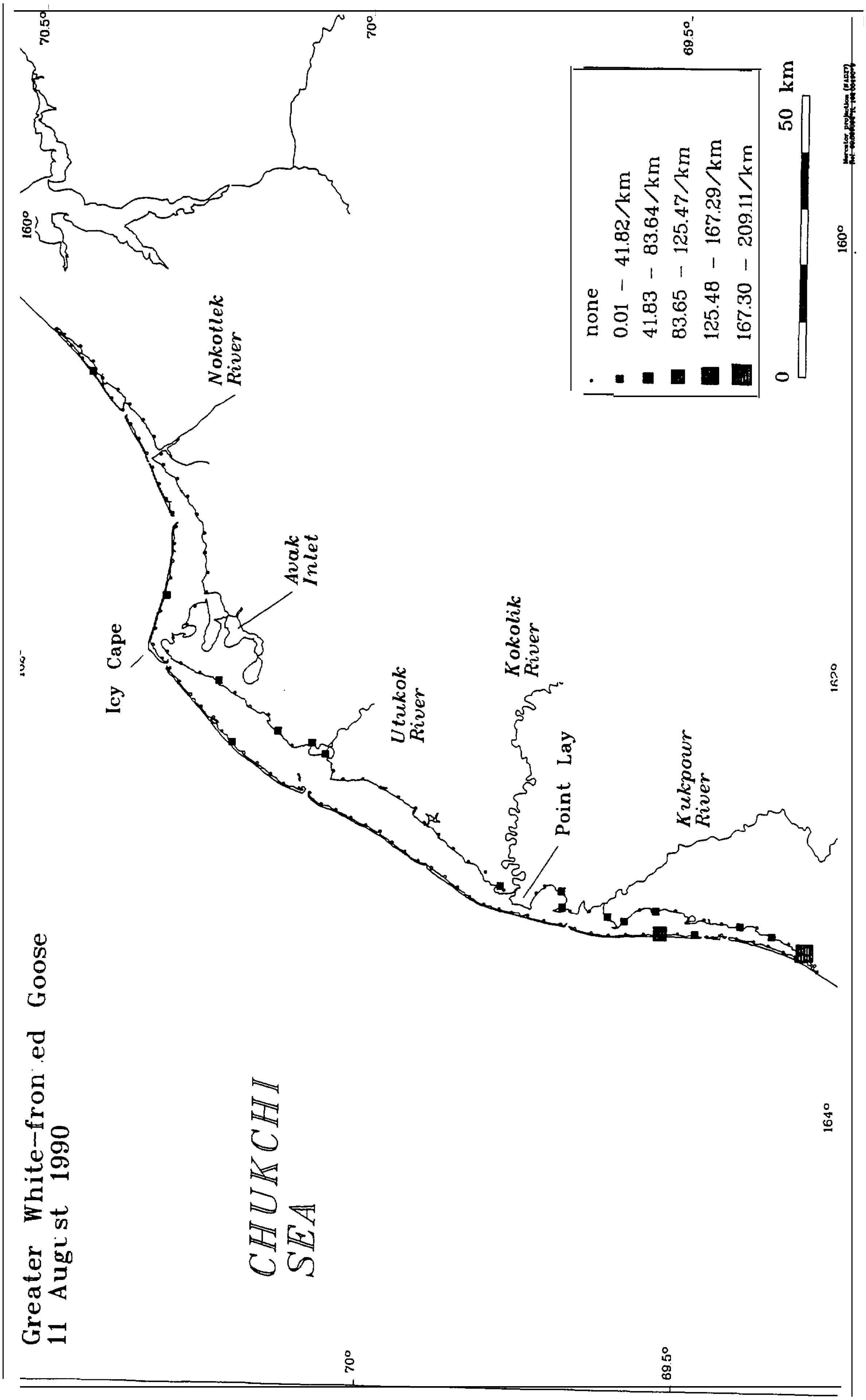
Greater White–fronted Goose
11 September 1989

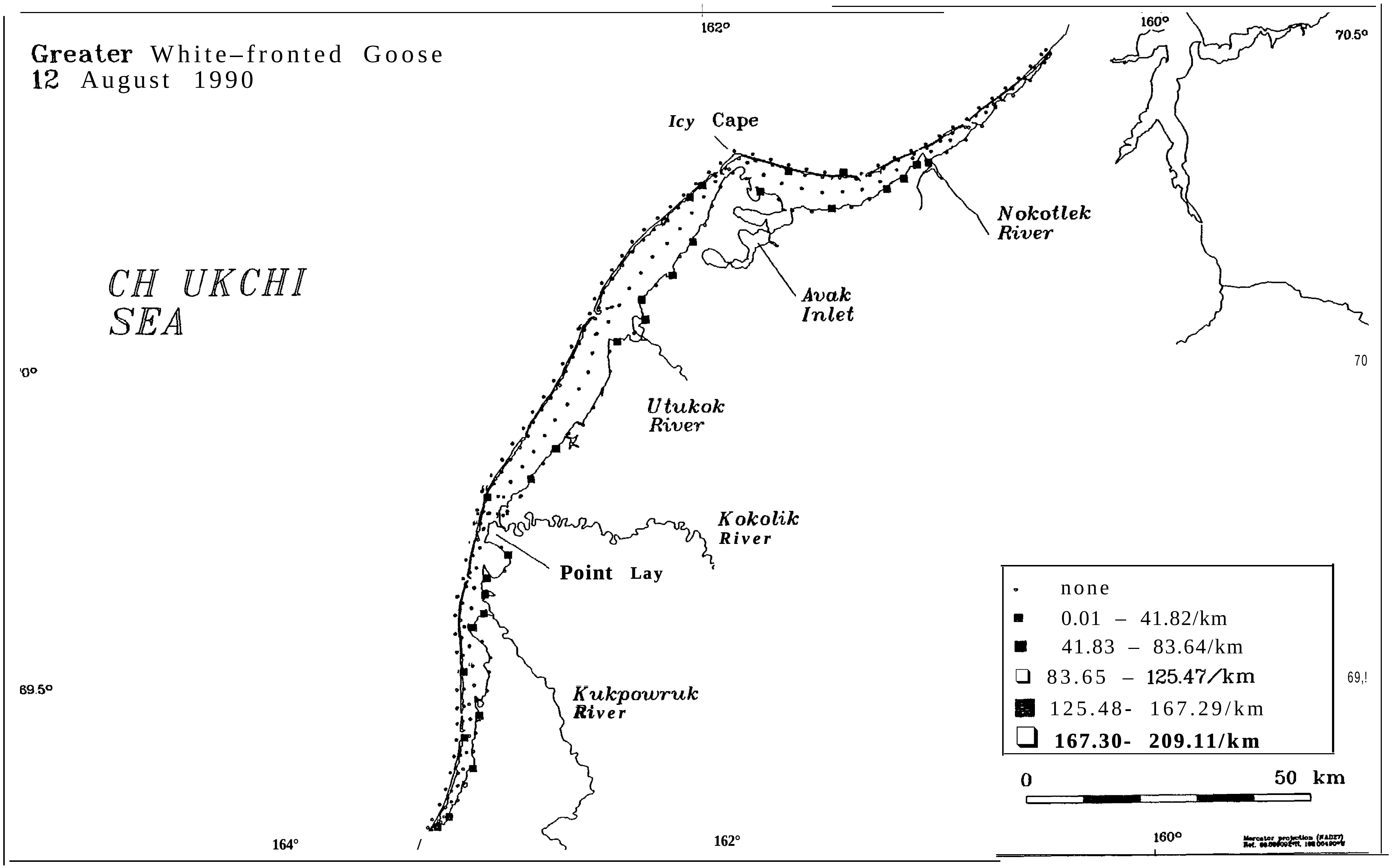


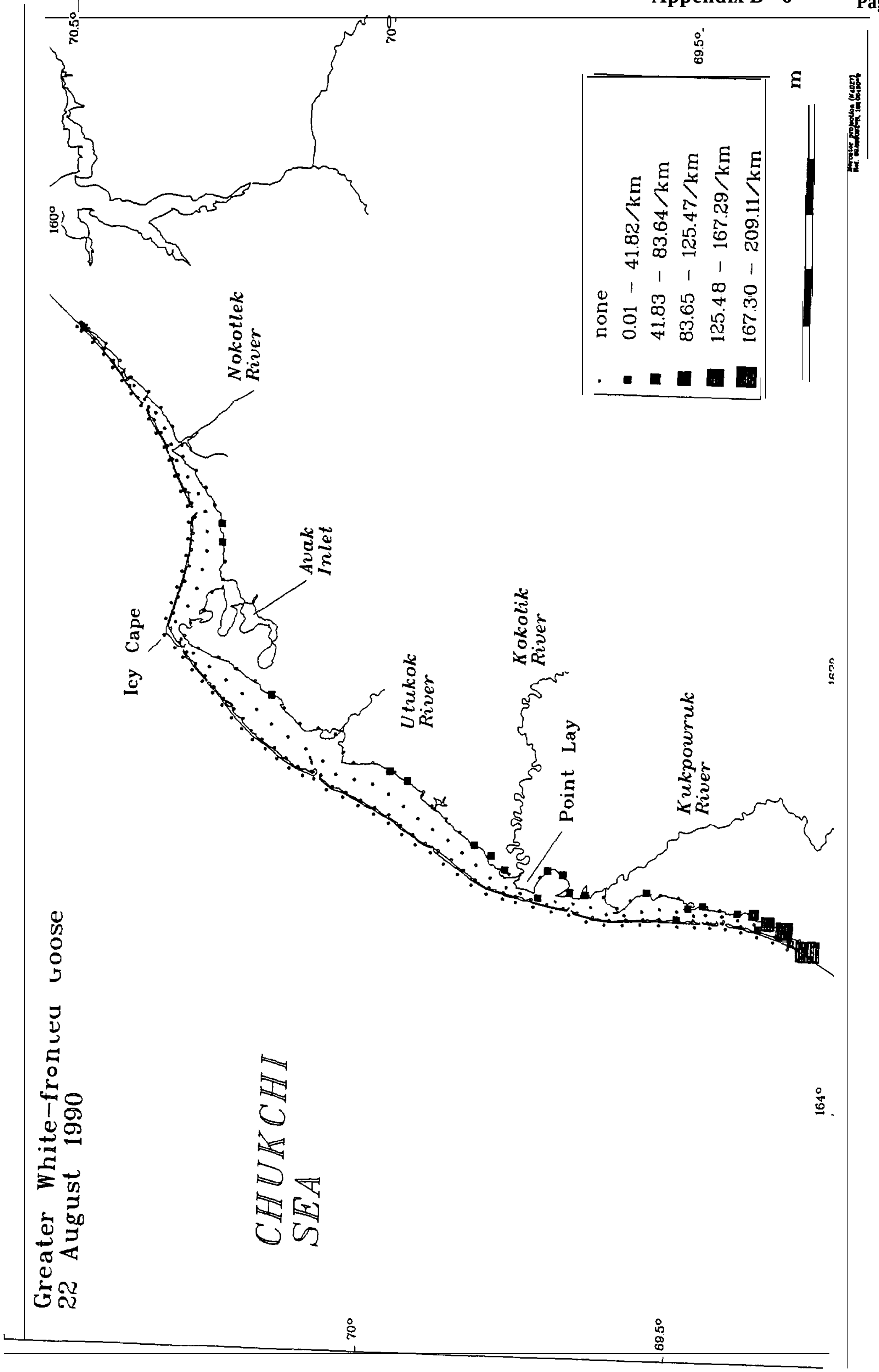


Greater White-fronted Goose
27 July 1990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
Non-standard calculation (see text)
none
0.01 - 41.82/km
41.83 - 83.64/km
83.65 - 125.47/km
125.48 - 167.29/km
167.30 - 209.11/km
0
50 km
70.5°
70°
69.5°
160°

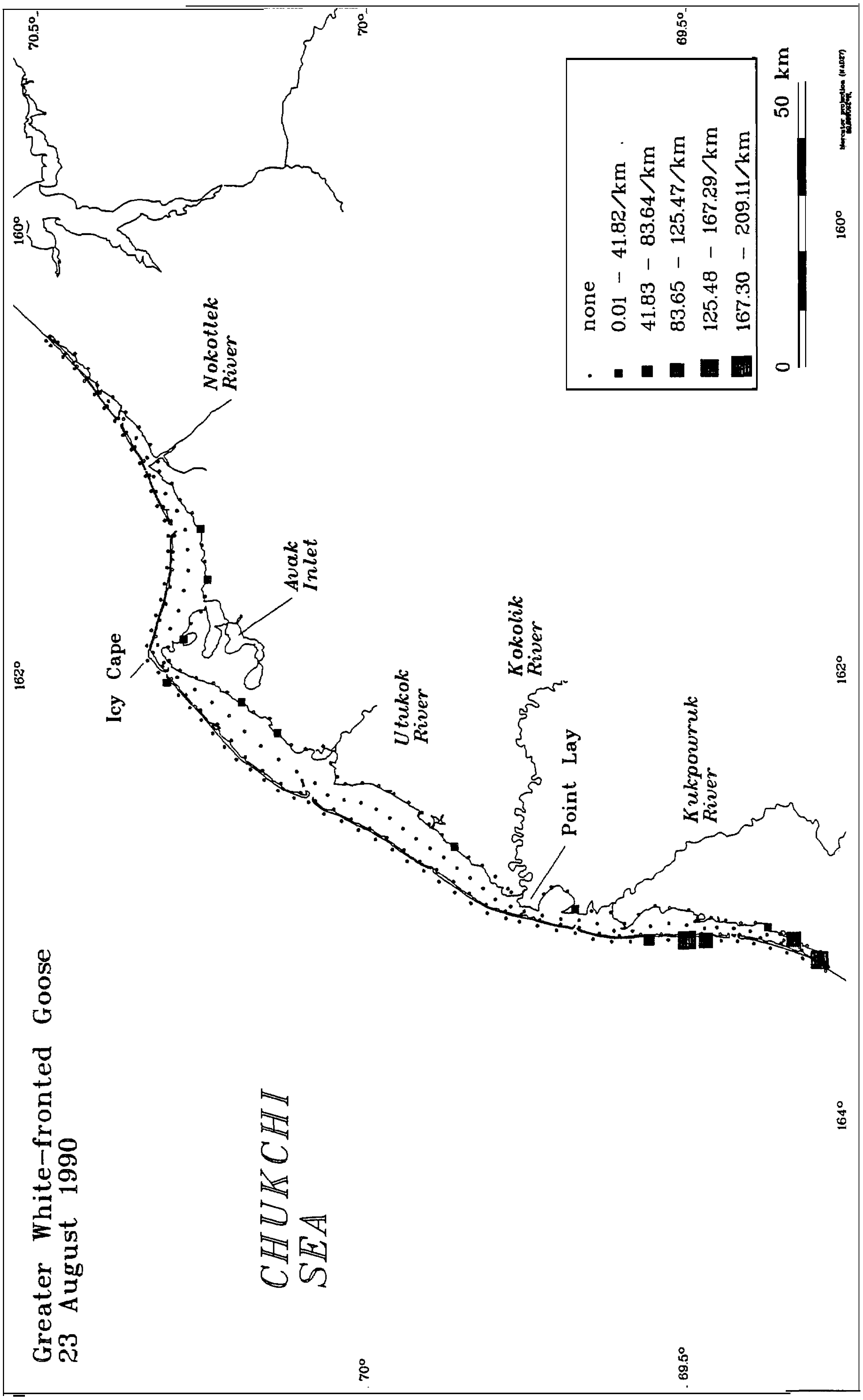

Greater White-fronted Goose
28 July 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70°
70
69.5
1640
1620
160°
none
0.01 – 41.82/km
41.83 – 83.64/km
83.65 - 125.47/km
125.48- 167.29/km
167.30- 209.11/km
0
50 km

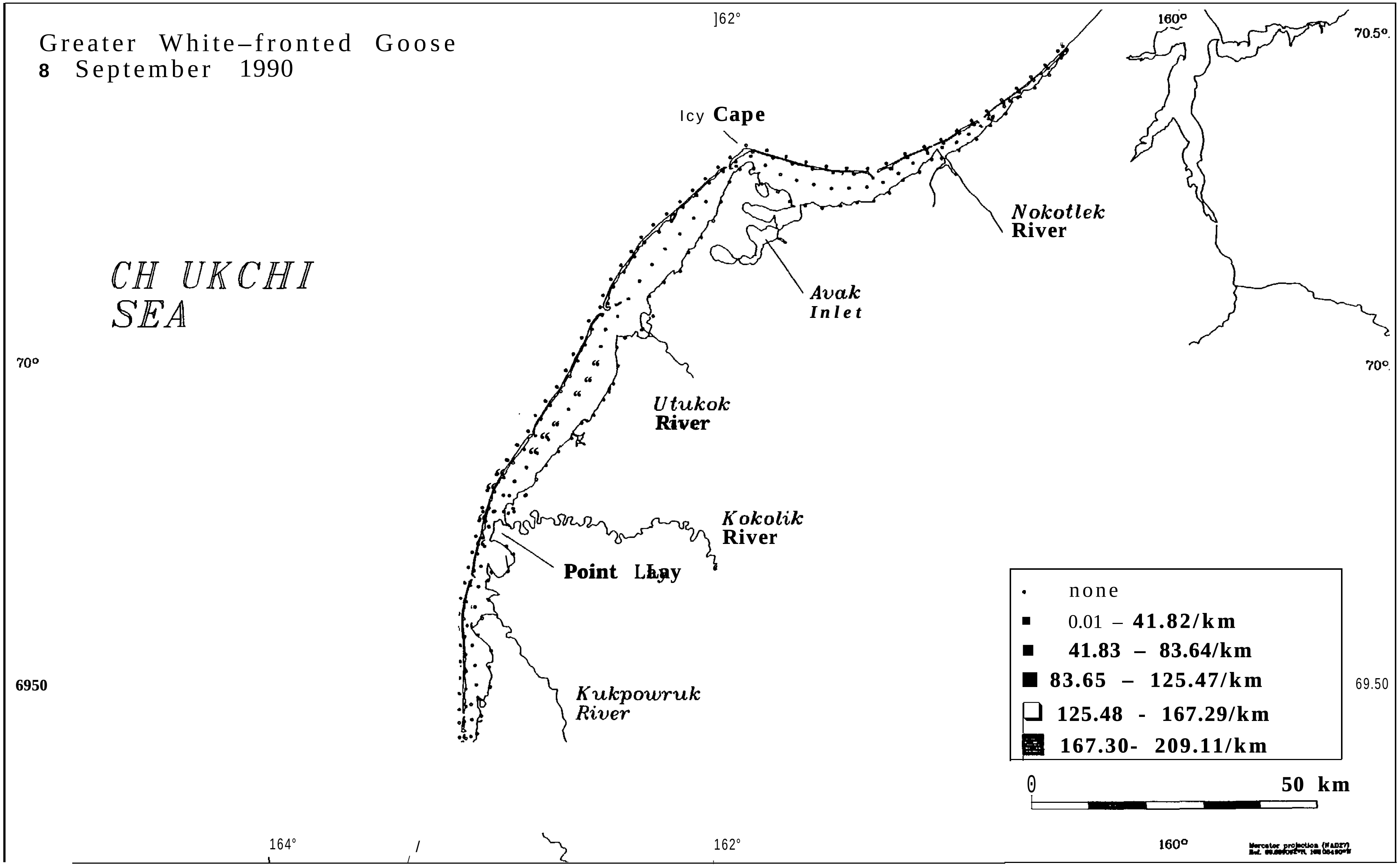

Greater White-fronted Goose
11 August 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowr River
none
0.01 – 41.82/km
41.83 – 83.64/km
83.65 – 125.47/km
125.48 – 167.29/km
167.30 – 209.11/km
0
50 km
70.5°
70°
69.5°
160°
164°
70°
69.5°


Greater White-fronted Goose
12 August 1990
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
CH UKCHI SEA
162°
160°
70.5°
70
69.5°
164°
none
0.01 – 41.82/km
41.83 – 83.64/km
83.65 – 125.47/km
125.48- 167.29/km
167.30- 209.11/km
0
50 km

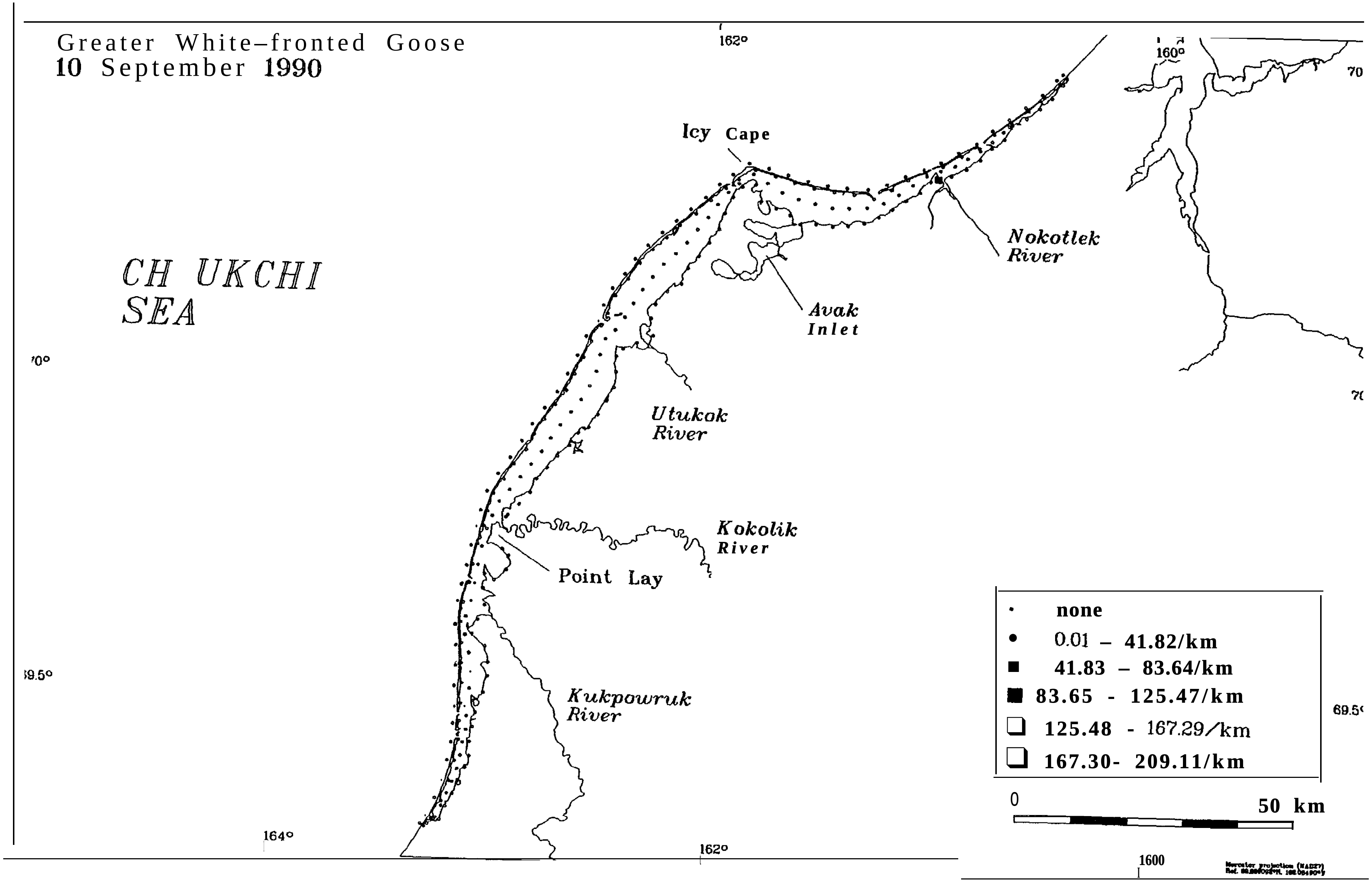


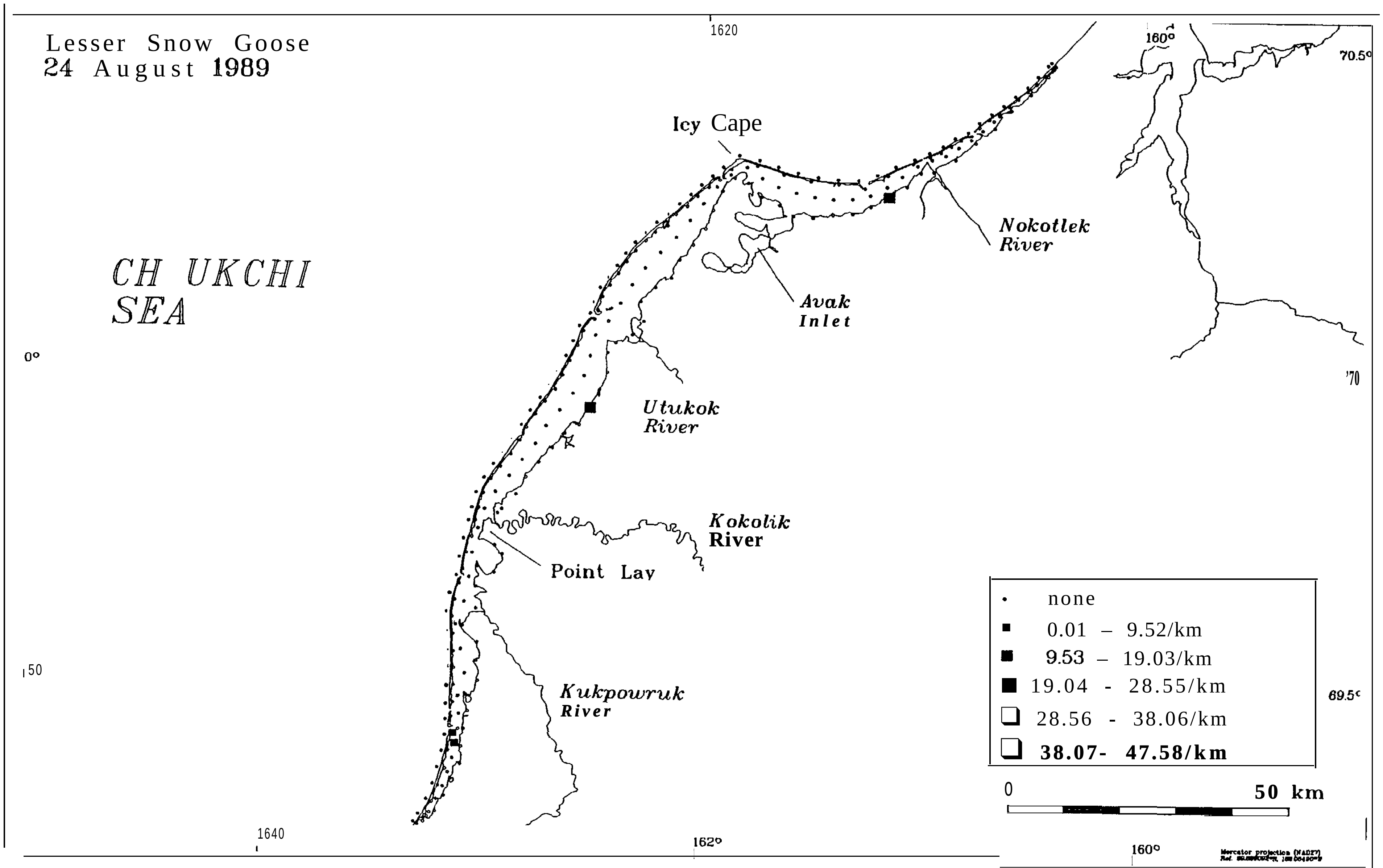
Greater White-fronted Goose
22 August 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 41.82/km
41.83 - 83.64/km
83.65 - 125.47/km
125.48 - 167.29/km
167.30 - 209.11/km
70.5°
70°
69.5°
160°
164°

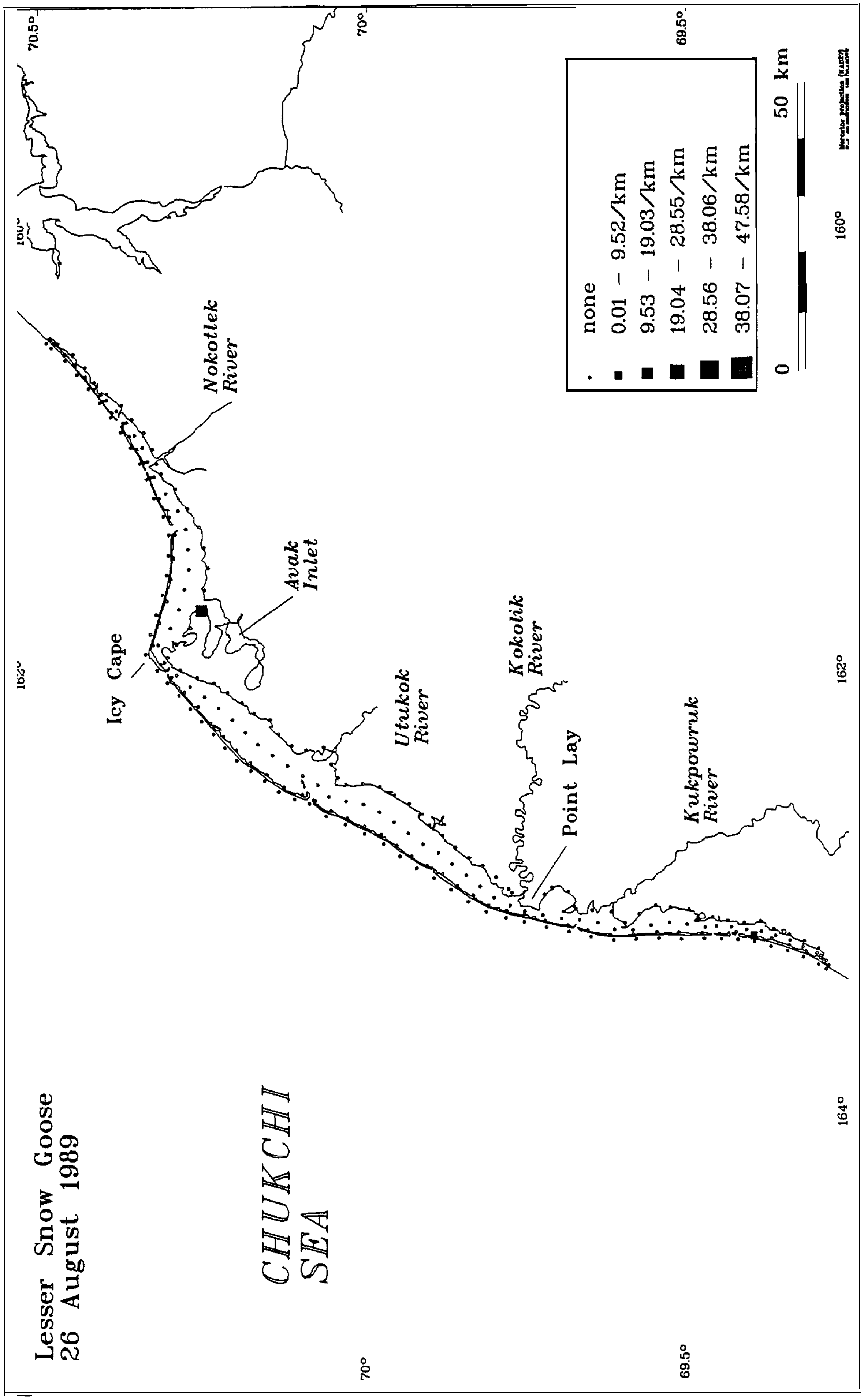

Greater White-fronted Goose
23 August 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 41.82/km
41.83 – 83.64/km
83.65 – 125.47/km
125.48 – 167.29/km
167.30 – 209.11/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

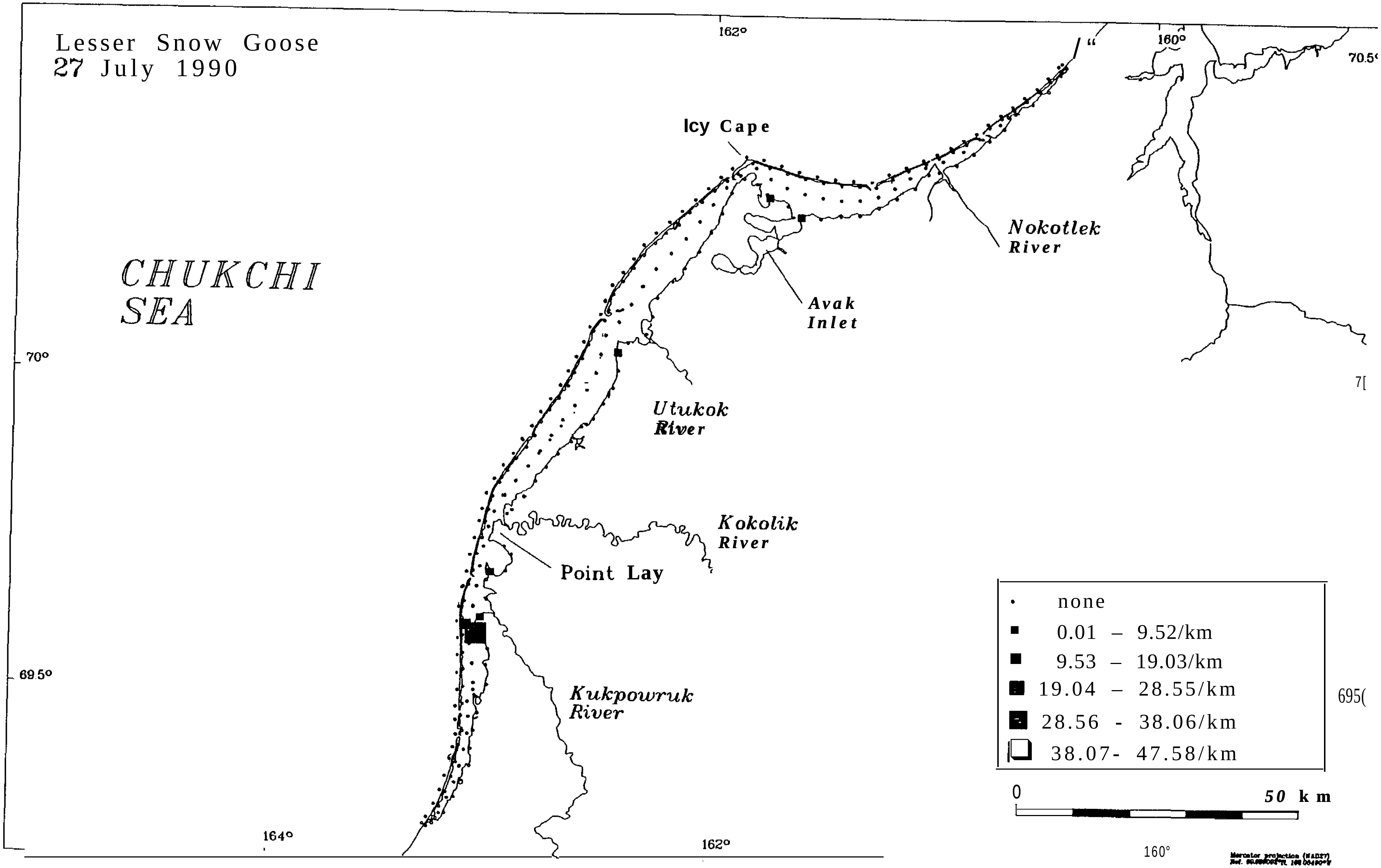

Greater White–fronted Goose
8 September 1990
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
70°
6950
69.50
164°
162°
160°
• none
■ 0.01 – 41.82/km
■ 41.83 – 83.64/km
■ 83.65 – 125.47/km
❑ 125.48 - 167.29/km
▦ 167.30- 209.11/km
0
50 km

Greater White–fronted Goose
10 September 1990

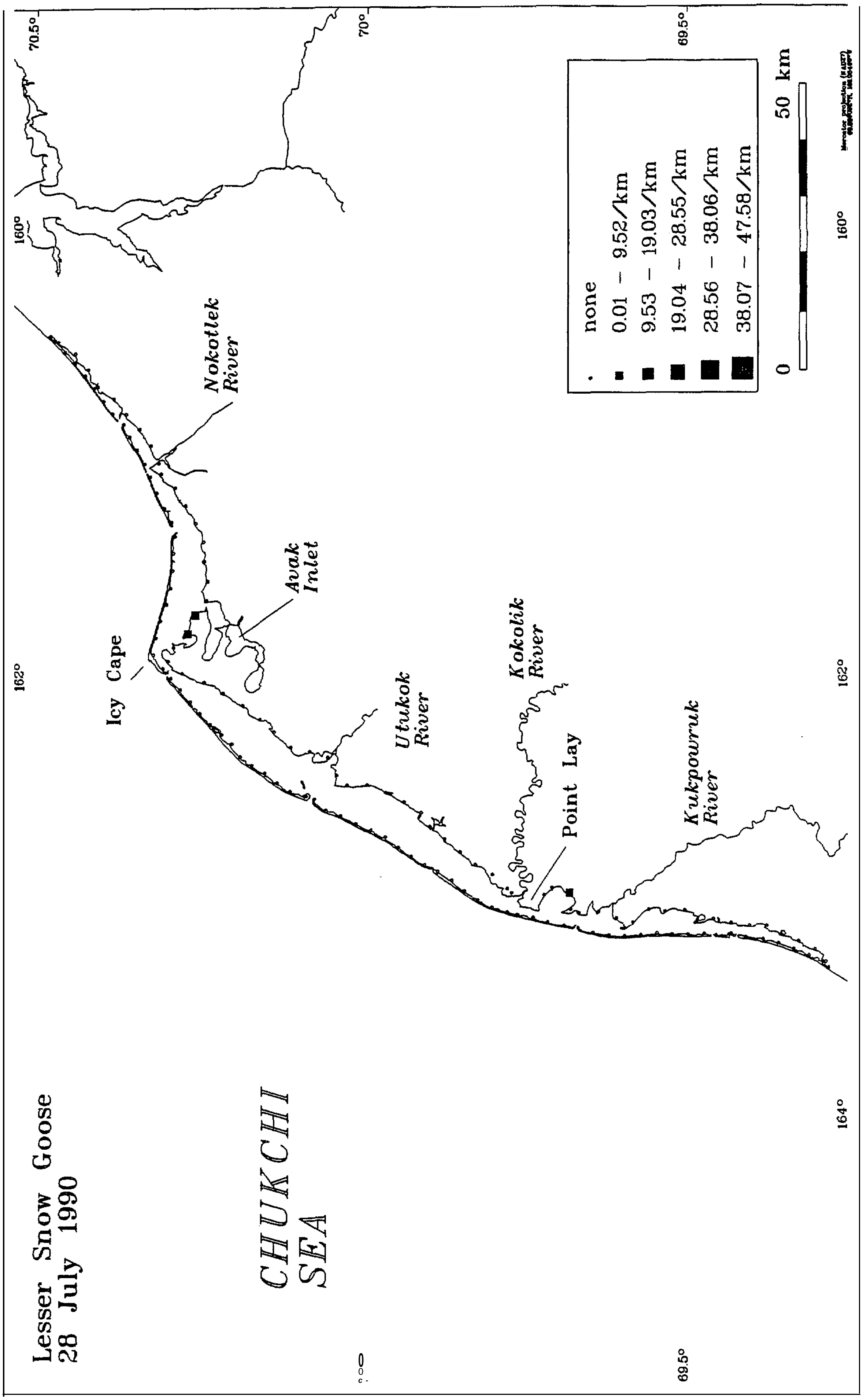


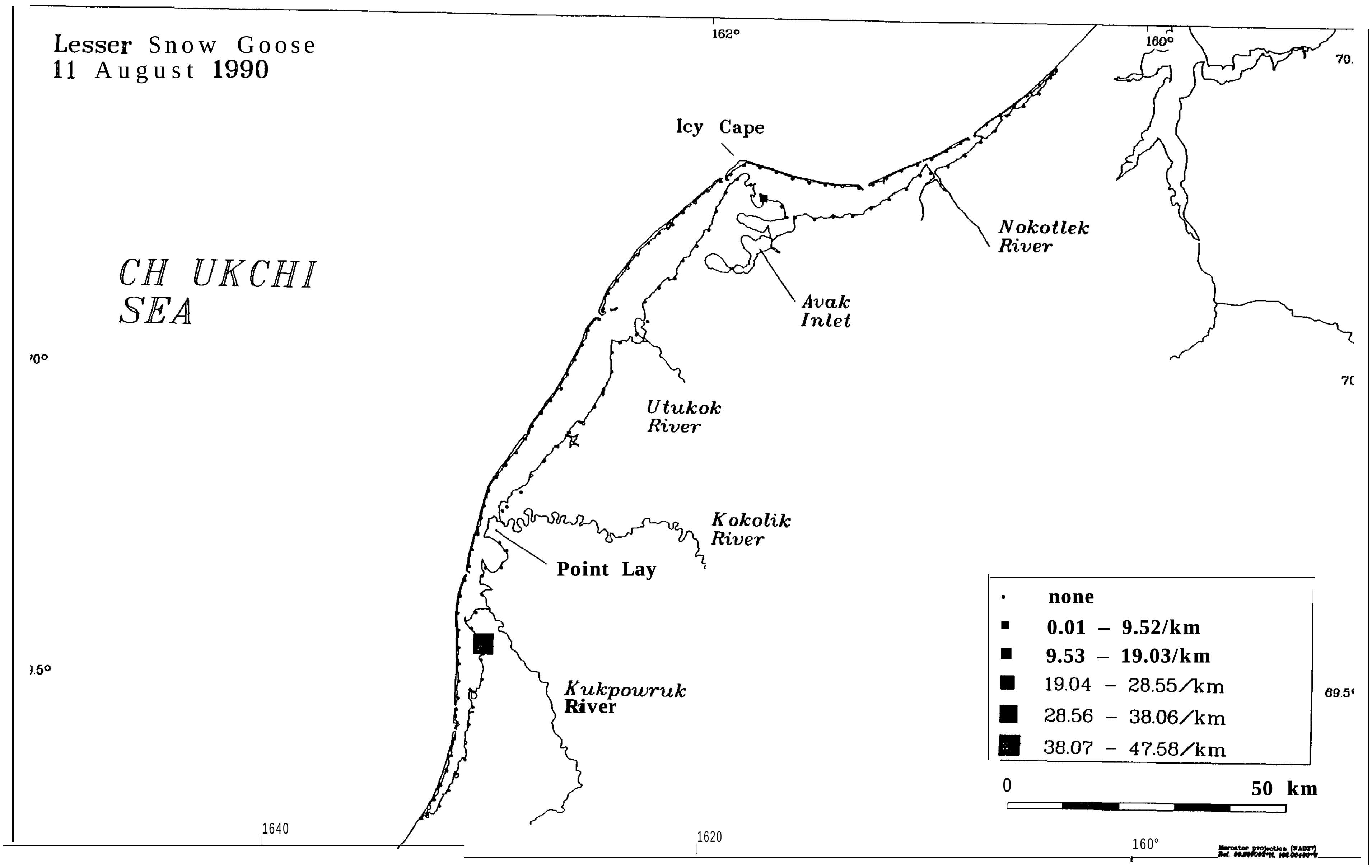

Lesser Snow Goose
24 August 1989
1620
160°
70.5°
Icy Cape
Nokotlek River
CH UKCHI SEA
Avak Inlet
0°
'70
Utukok River
Kokolik River
Point Lay
none
0.01 – 9.52/km
9.53 – 19.03/km
19.04 - 28.55/km
28.56 - 38.06/km
38.07- 47.58/km
50
Kukpowruk River
69.5°
0
50 km
1640
162°
160°

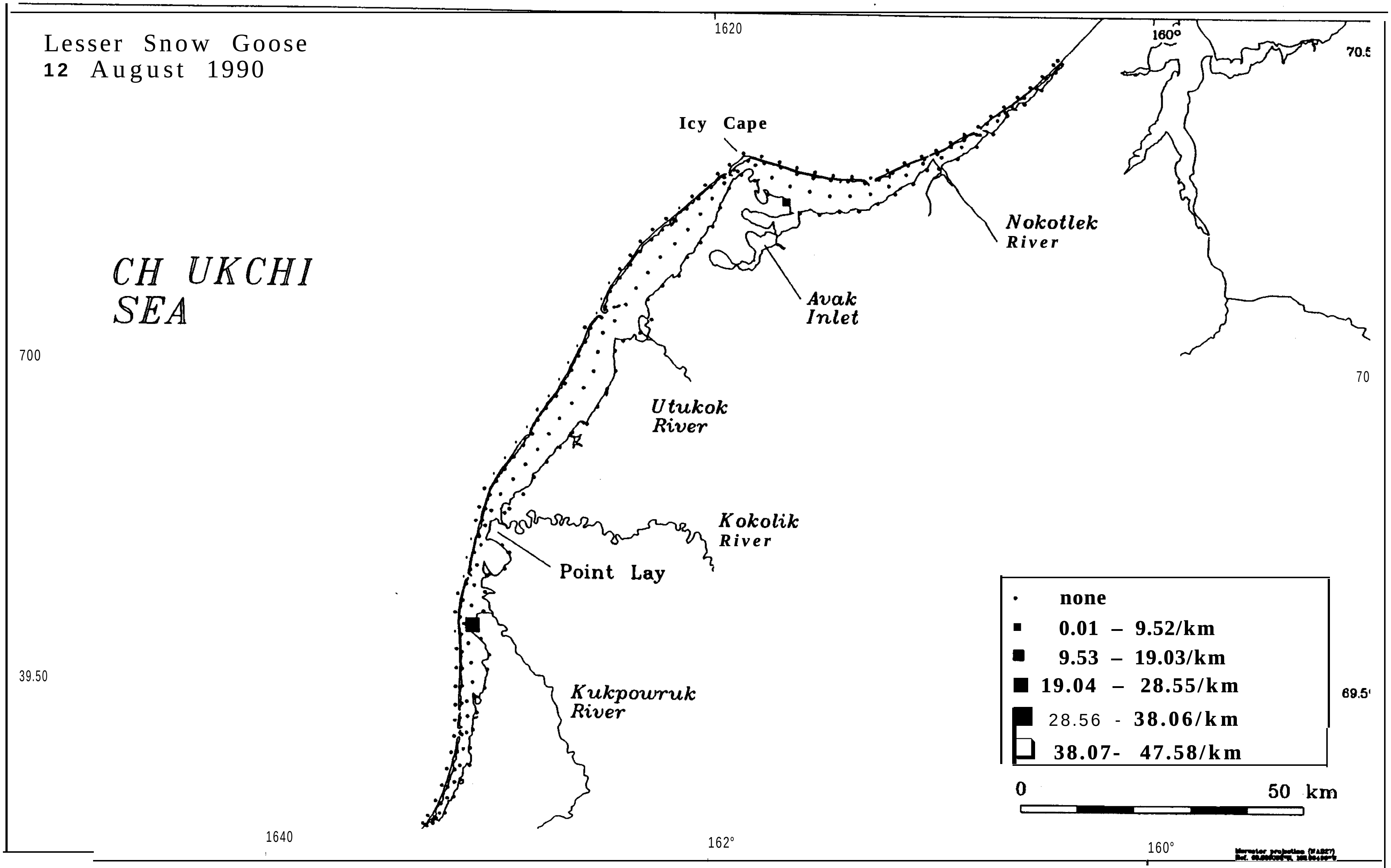

Lesser Snow Goose
26 August 1989
CHUKCHI SEA
Icy Cape
Avak Inlet
Nokotlek River
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 9.52/km
9.53 – 19.03/km
19.04 – 28.55/km
28.56 – 38.06/km
38.07 – 47.58/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

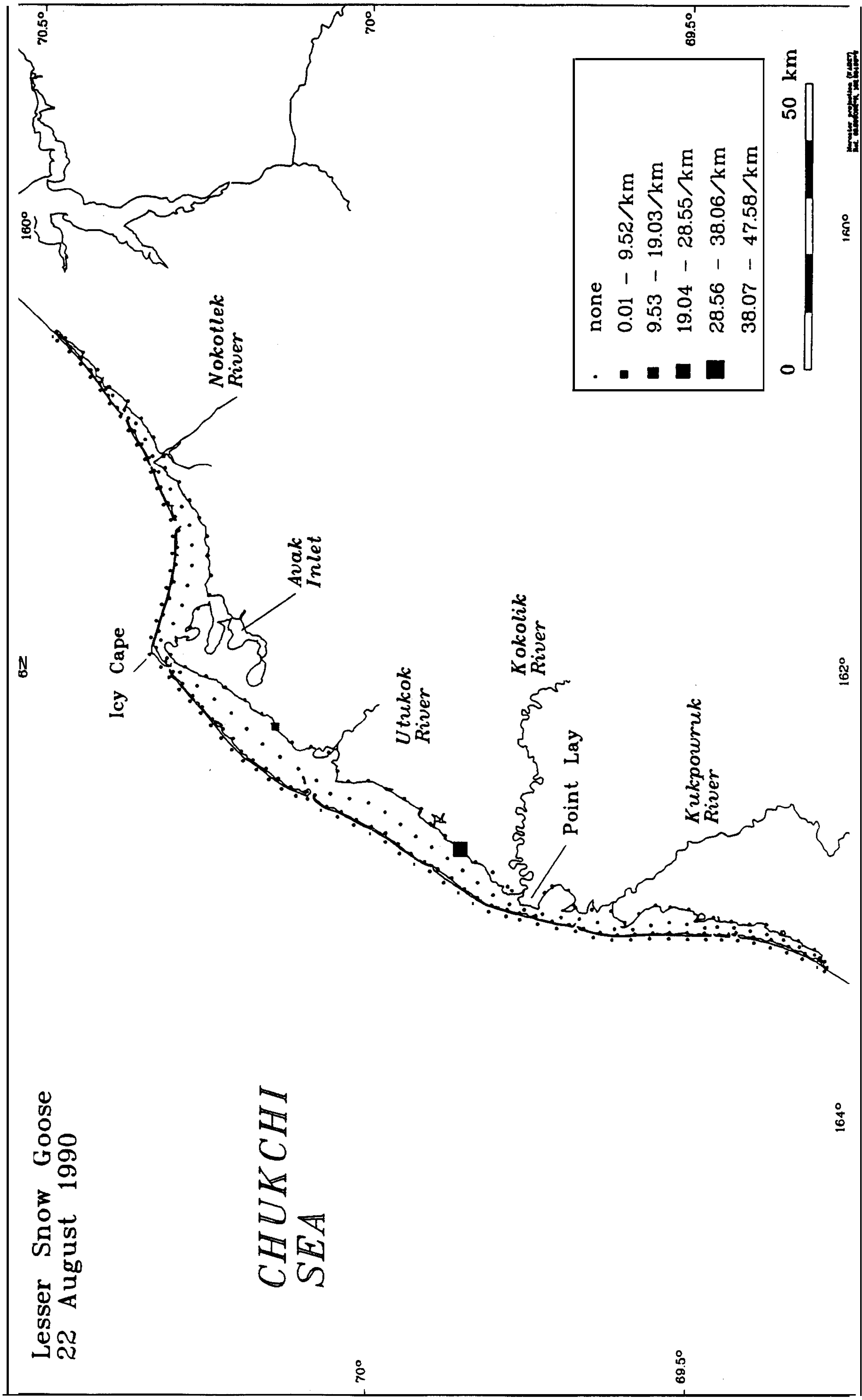


Lesser Snow Goose
27 July 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
69.5°
164°
162°
160°
• none
■ 0.01 – 9.52/km
■ 9.53 – 19.03/km
■ 19.04 – 28.55/km
■ 28.56 - 38.06/km
□ 38.07- 47.58/km
0
50 km

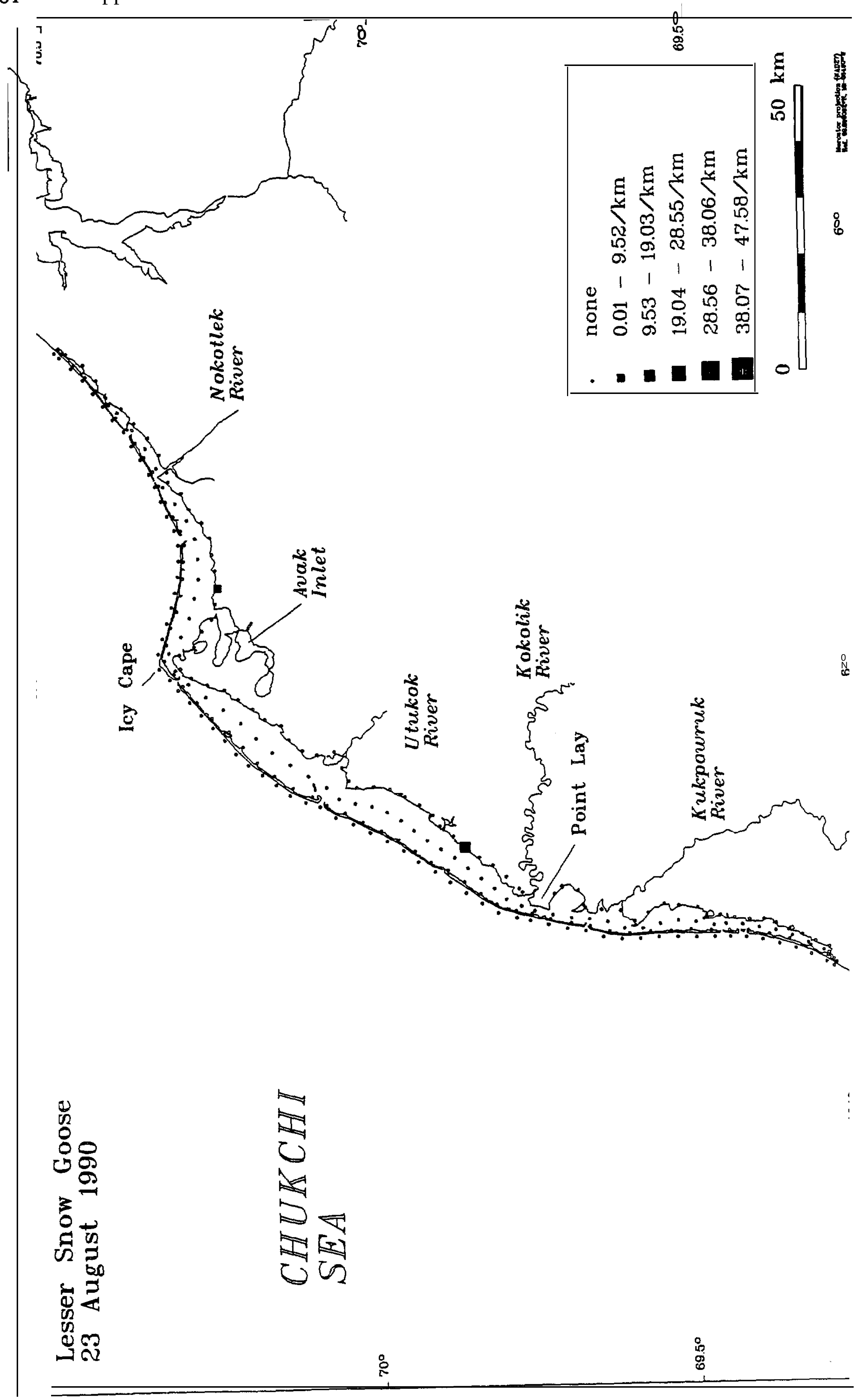

Lesser Snow Goose
28 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 9.52/km
9.53 – 19.03/km
19.04 – 28.55/km
28.56 – 38.06/km
38.07 – 47.58/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°


Lesser Snow Goose
11 August 1990
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70°
69.5°
none
0.01 – 9.52/km
9.53 – 19.03/km
19.04 – 28.55/km
28.56 – 38.06/km
38.07 – 47.58/km
0
50 km

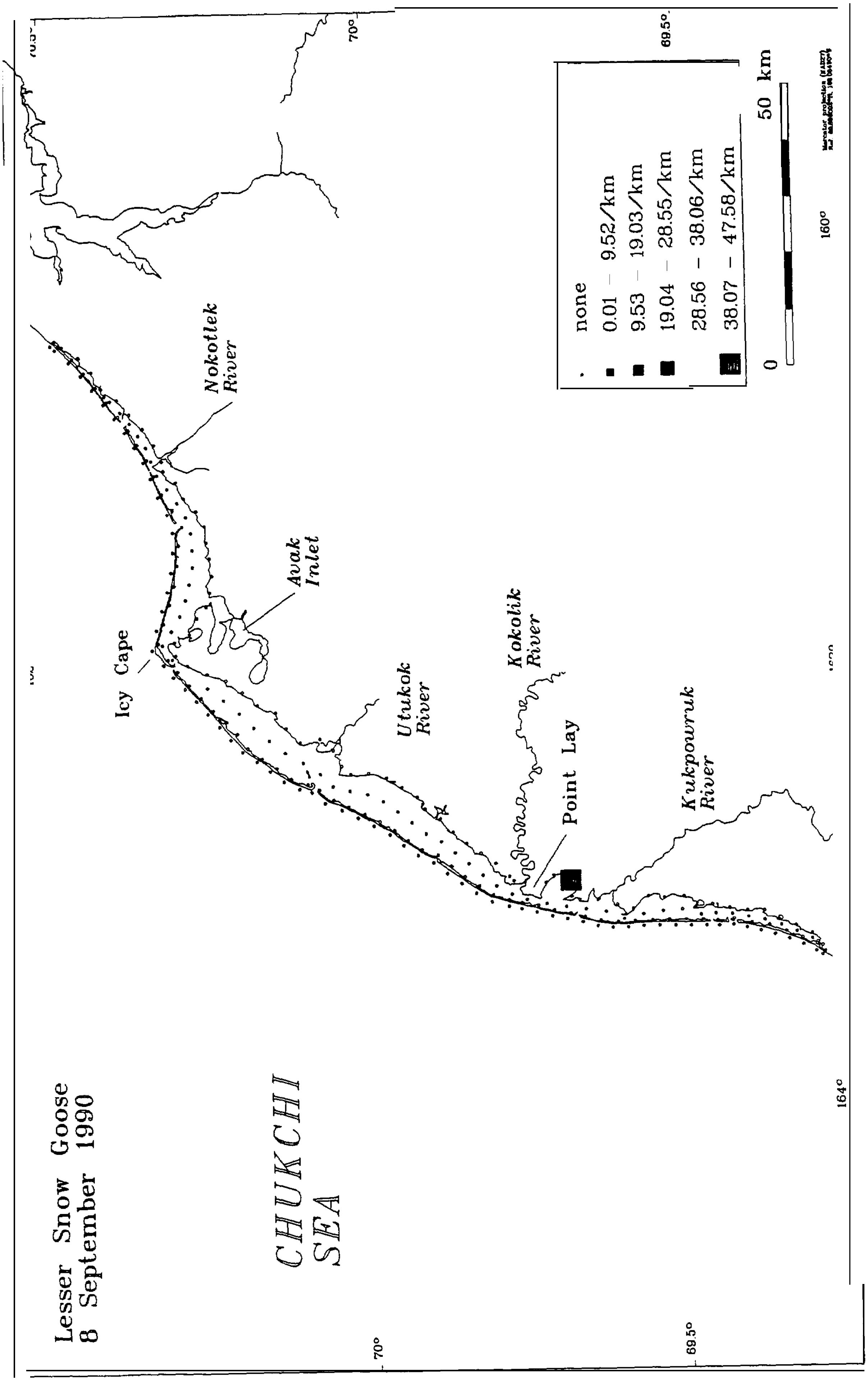

Lesser Snow Goose
12 August 1990
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 9.52/km
9.53 – 19.03/km
19.04 – 28.55/km
28.56 - 38.06/km
38.07- 47.58/km
0
50 km
1620
160°
70.5
700
70
39.50
69.5
1640
162°
160°

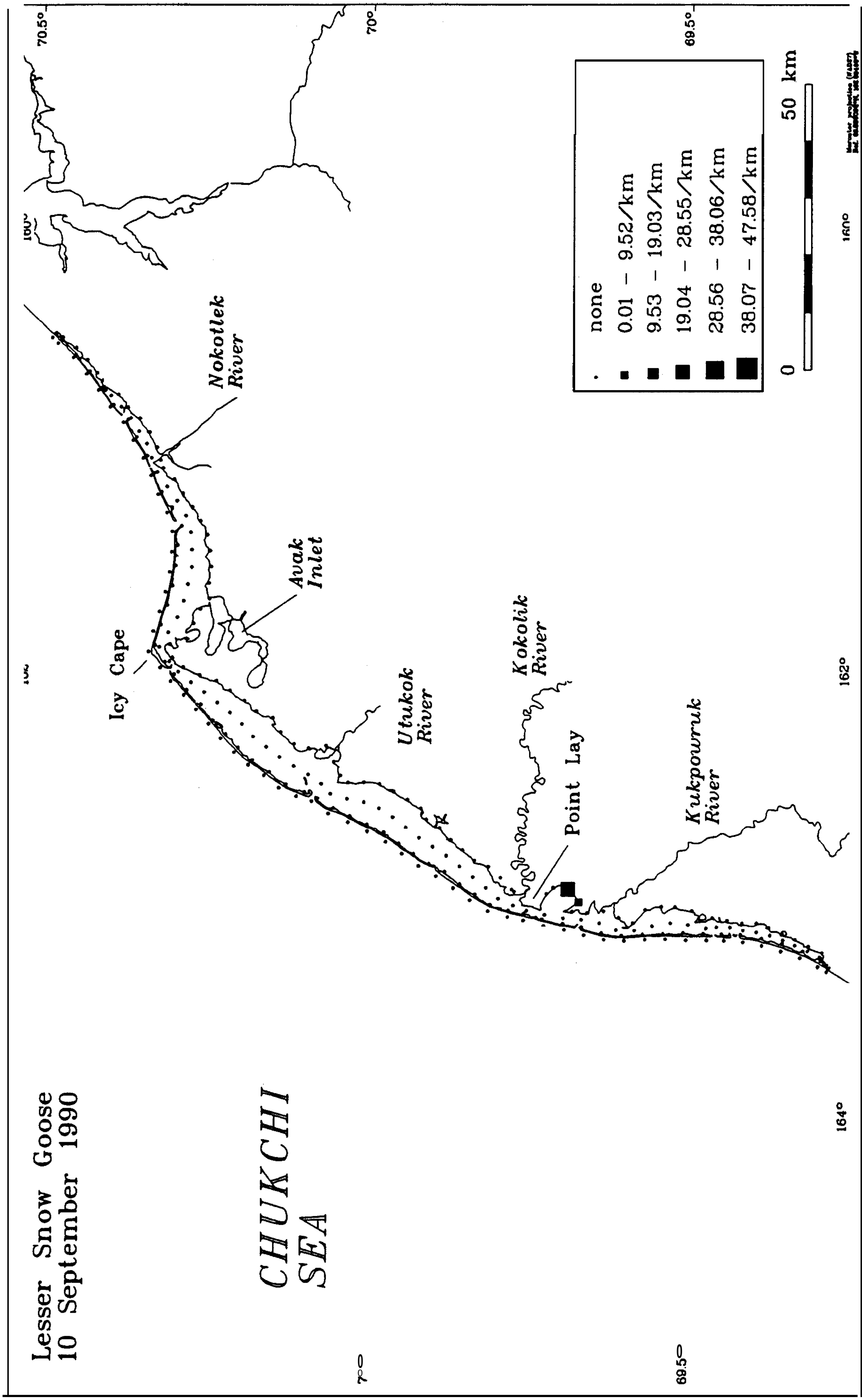


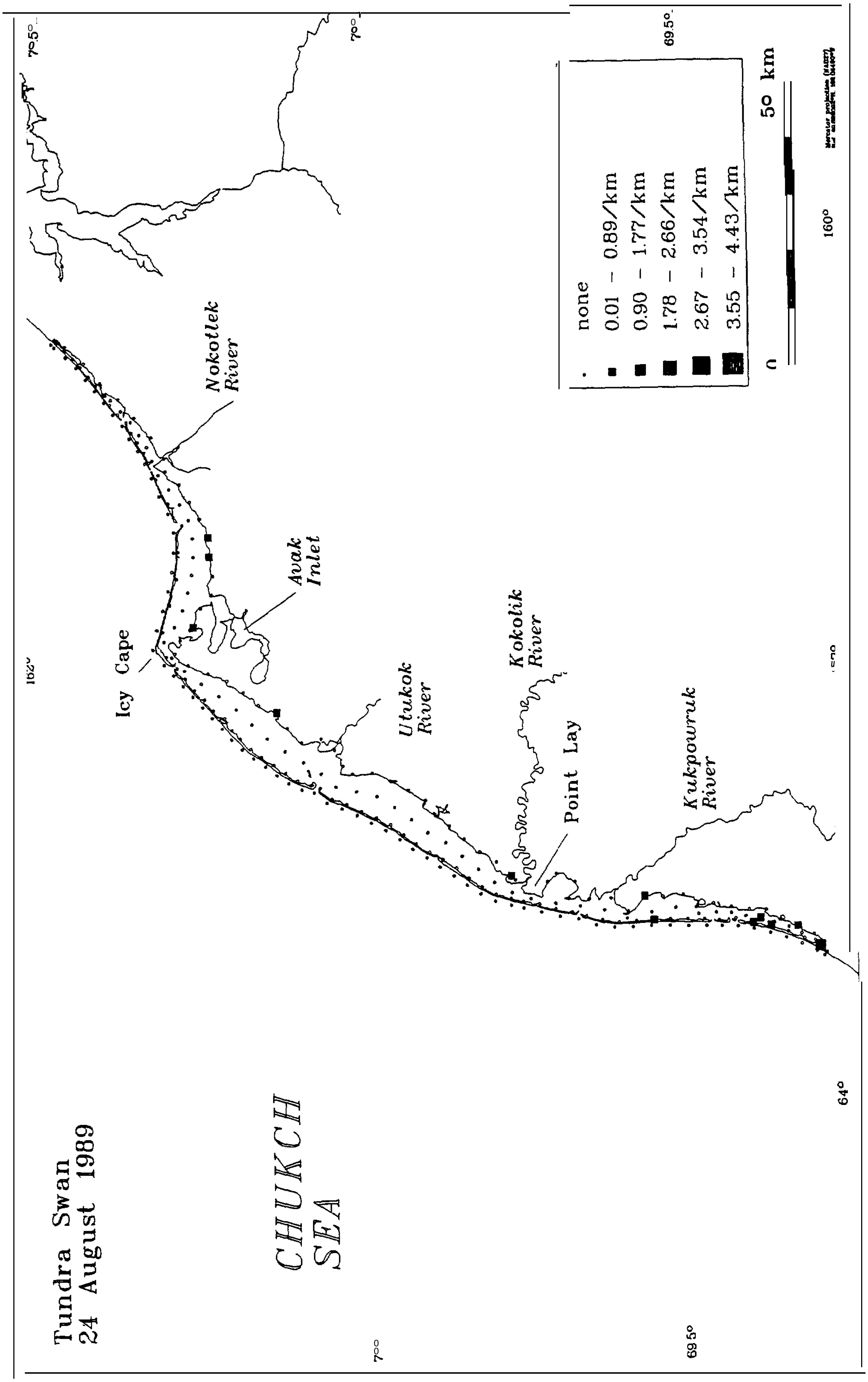
Lesser Snow Goose
22 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 9.52/km
9.53 - 19.03/km
19.04 - 28.55/km
28.56 - 38.06/km
38.07 - 47.58/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

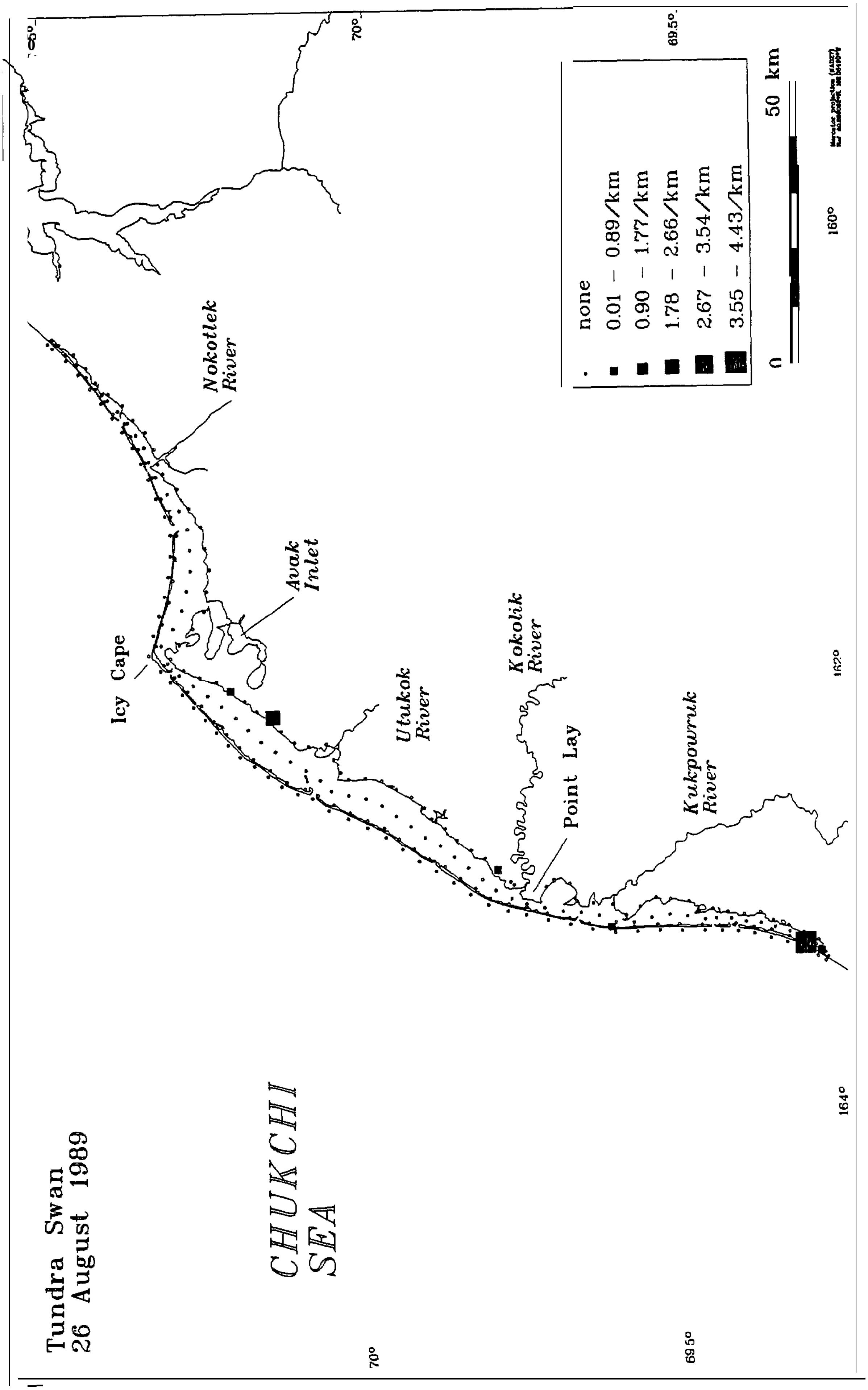


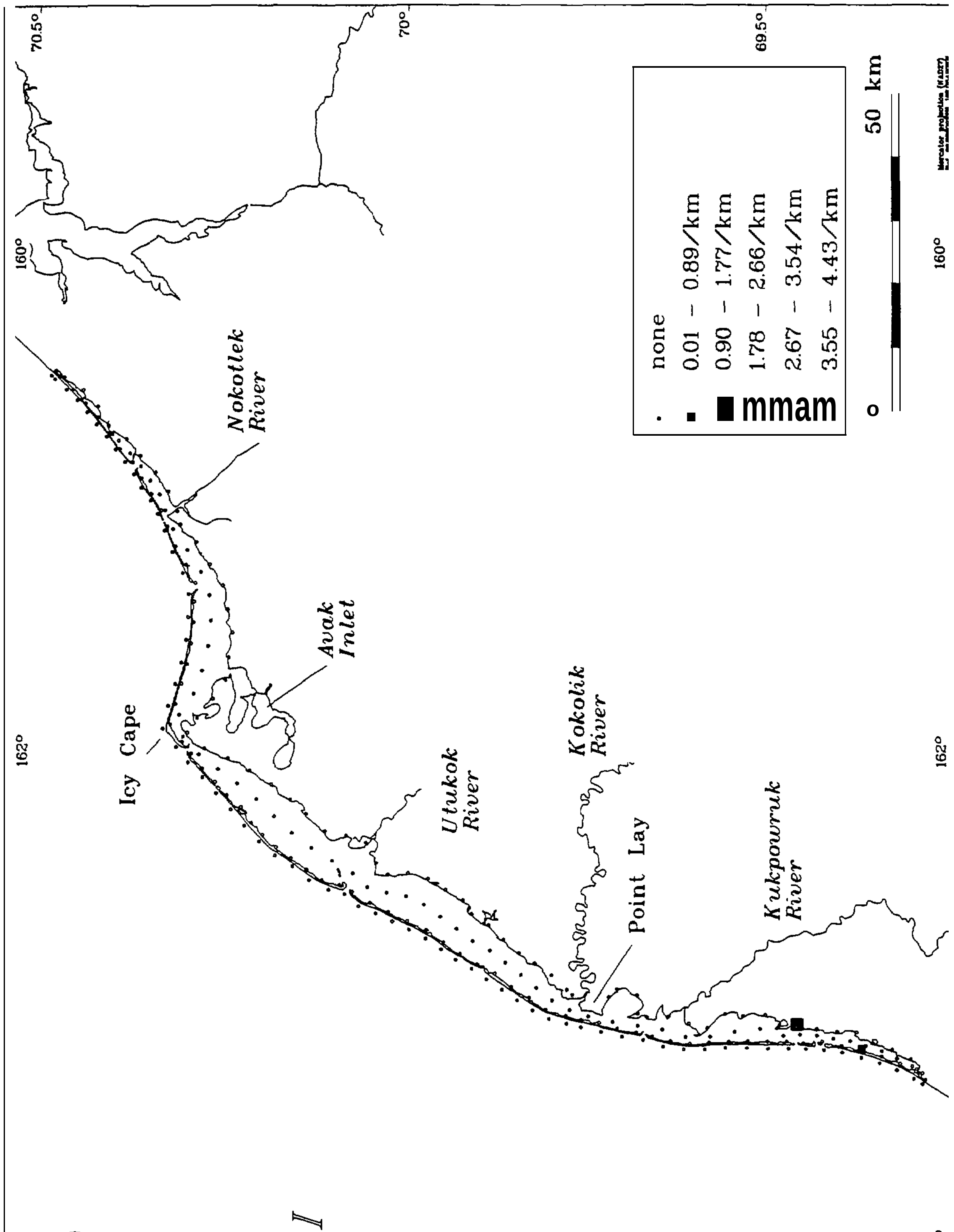
Lesser Snow Goose
23 August 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 9.52/km
9.53 – 19.03/km
19.04 – 28.55/km
28.56 – 38.06/km
38.07 – 47.58/km
0
50 km
70°
69.5°

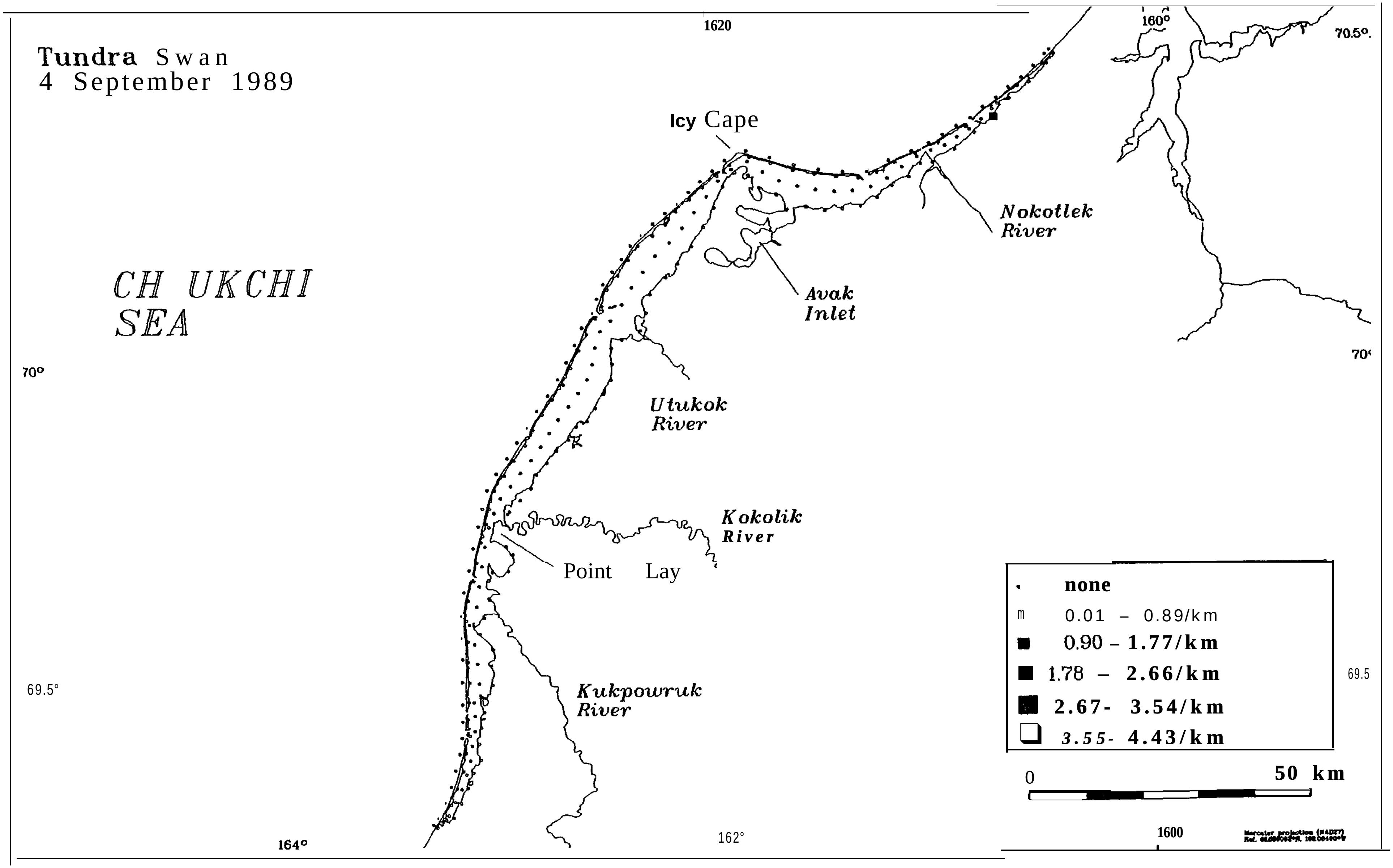

Lesser Snow Goose
8 September 1990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 9.52/km
9.53 – 19.03/km
19.04 – 28.55/km
28.56 – 38.06/km
38.07 – 47.58/km
0
50 km
70°
69.5°
160°
164°

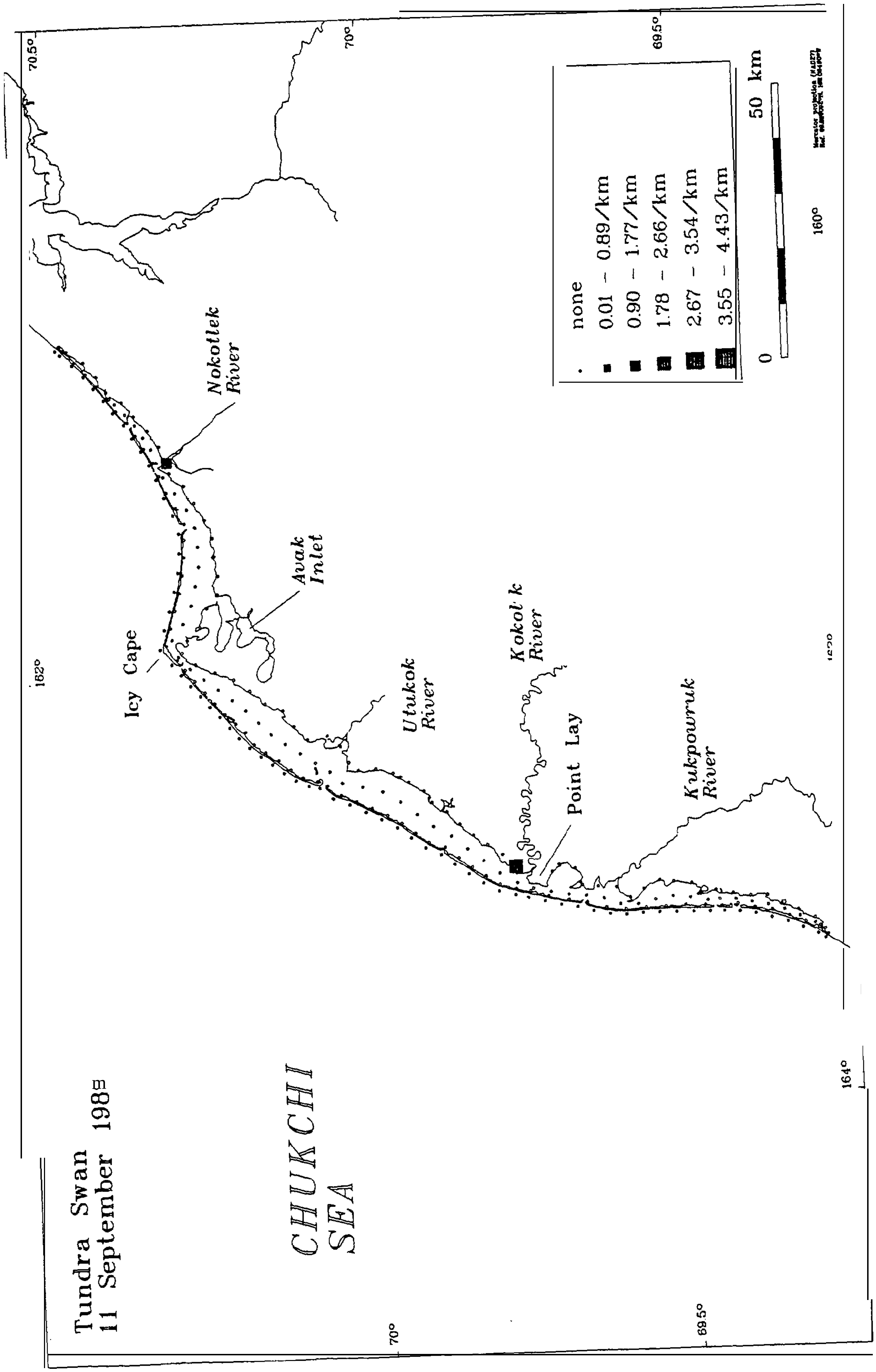

Lesser Snow Goose
10 September 1990
CHUKCHI
SEA
Icy Cape
Avak
Inlet
Nokotlek
River
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 9.52/km
9.53 - 19.03/km
19.04 - 28.55/km
28.56 - 38.06/km
38.07 - 47.58/km
0
50 km
70.5°
70°
69.5°
164°
162°
160°


Tundra Swan
24 August 1989
CHUKCH SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 0.89/km
0.90 – 1.77/km
1.78 – 2.66/km
2.67 – 3.54/km
3.55 – 4.43/km
0
50 km
70.5°
70°
69.5°
162°
160°
64°

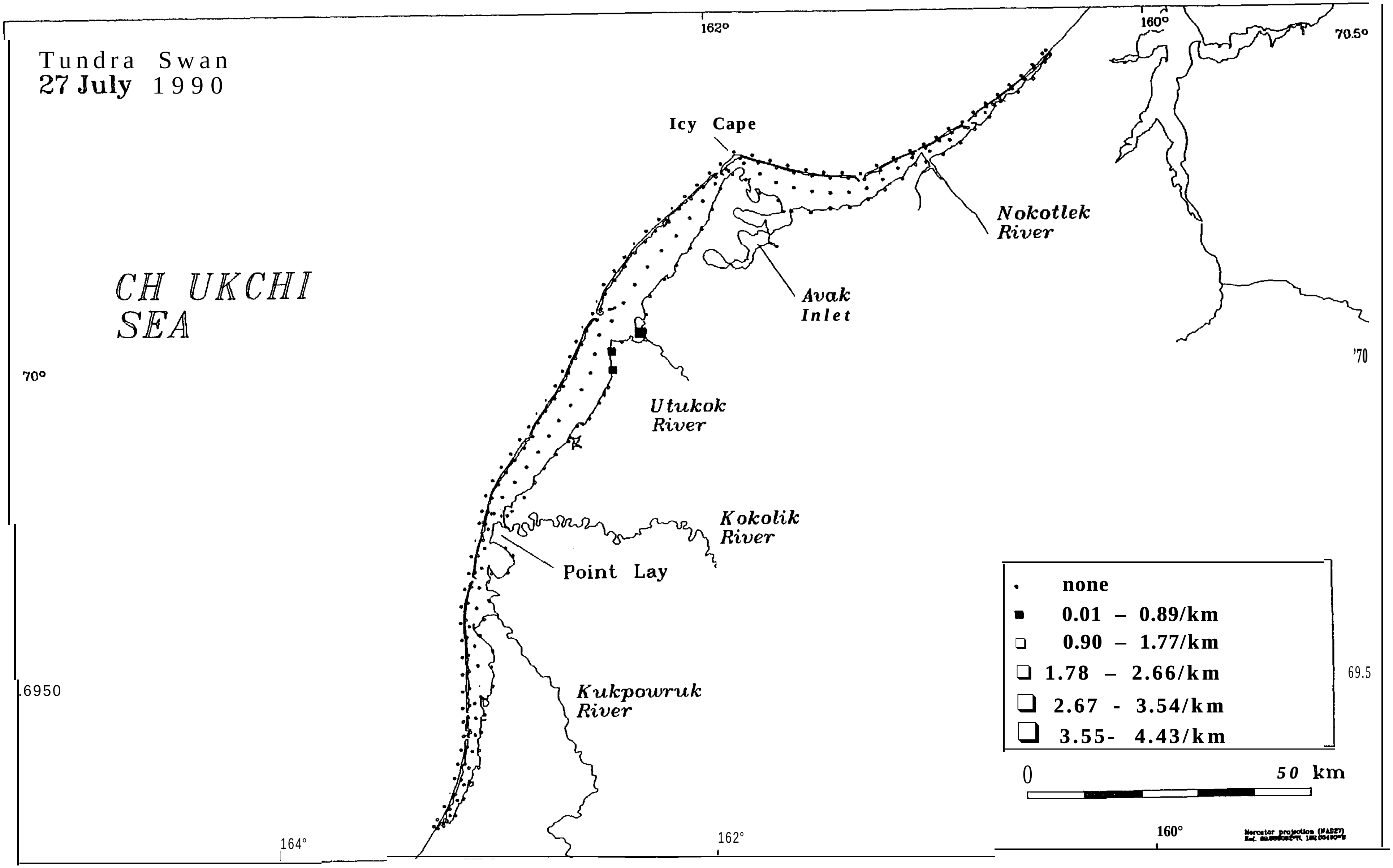

Tundra Swan
26 August 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.89/km
0.90 – 1.77/km
1.78 – 2.66/km
2.67 – 3.54/km
3.55 – 4.43/km
0
50 km
70°
69.5°
160°
162°
164°

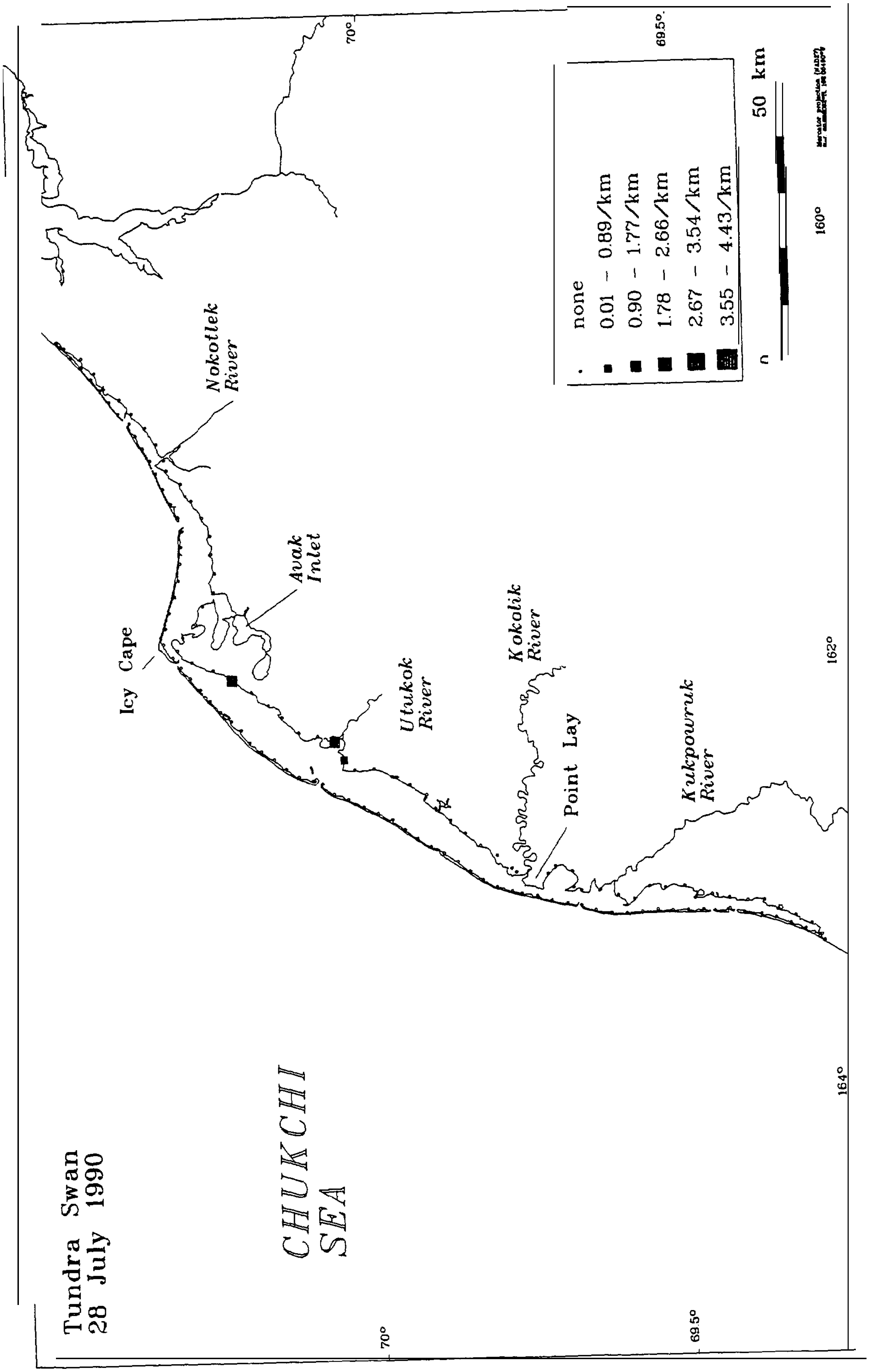

Tundra Swan
3 September 1989
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 0.89/km
0.90 - 1.77/km
1.78 - 2.66/km
2.67 - 3.54/km
3.55 - 4.43/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

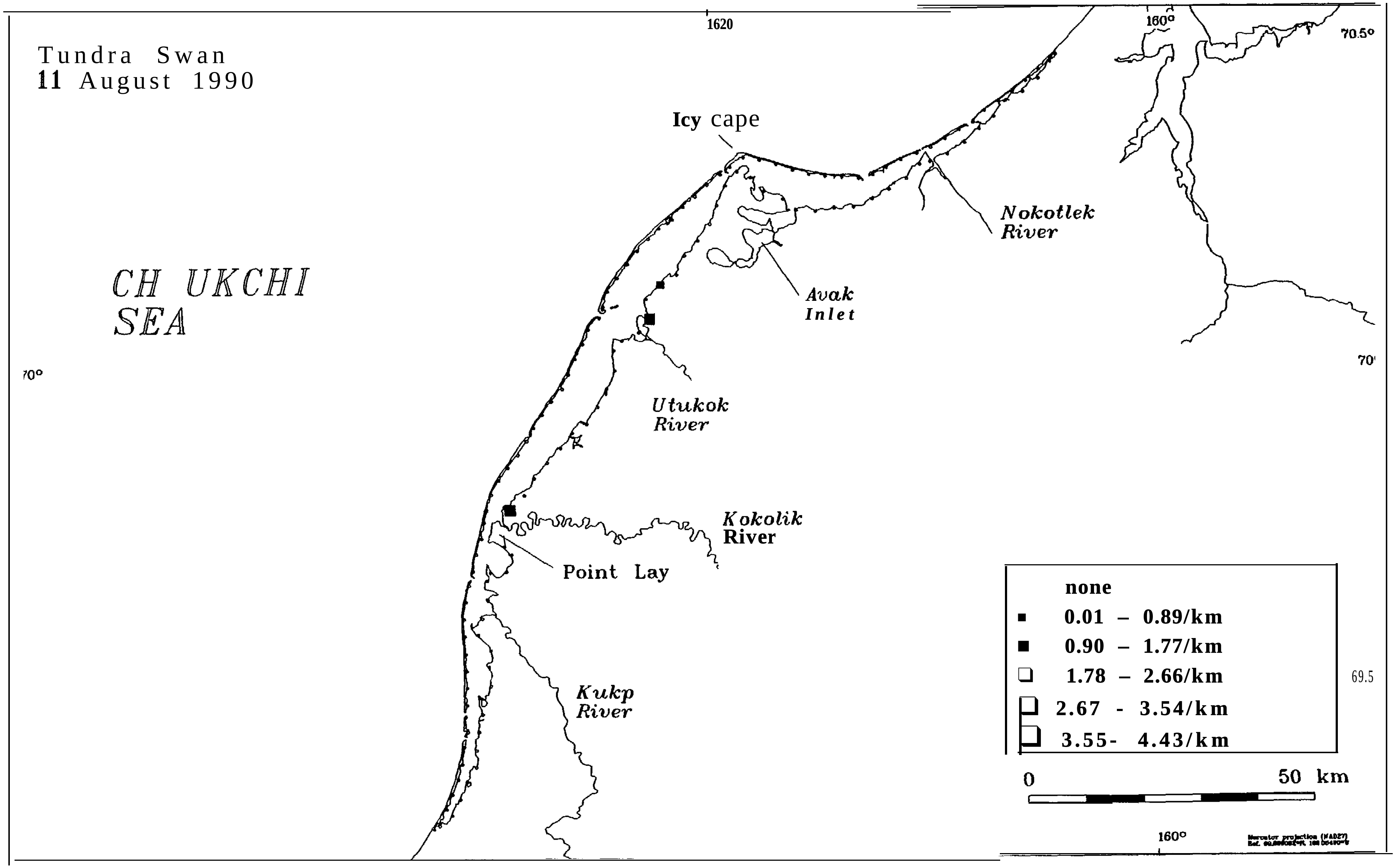

Tundra Swan
4 September 1989
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
1620
160°
70.5°
70°
70°
69.5°
69.5
164°
162°
1600
• none
0.01 – 0.89/km
0.90 – 1.77/km
1.78 – 2.66/km
2.67 - 3.54/km
3.55 - 4.43/km
0
50 km

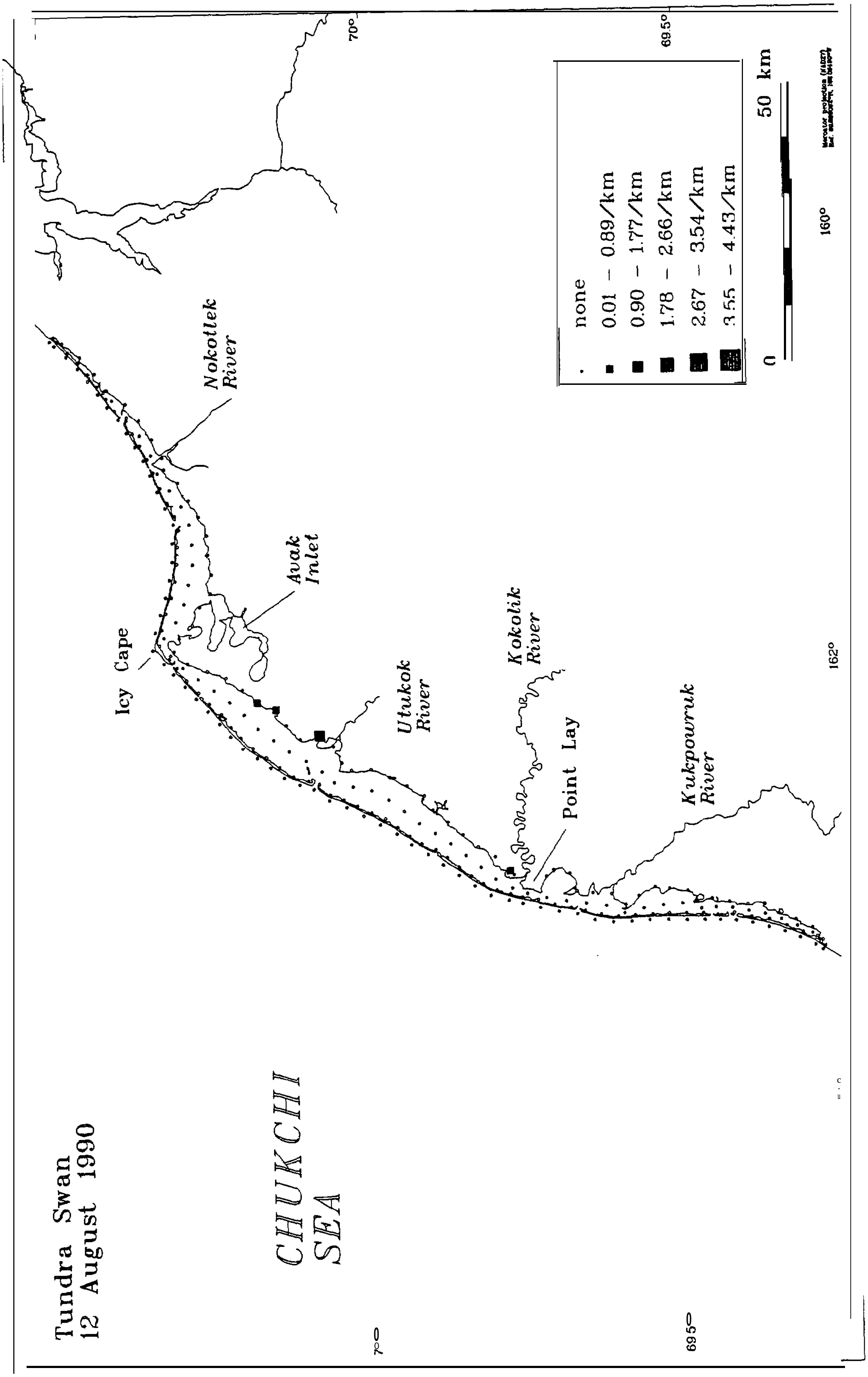


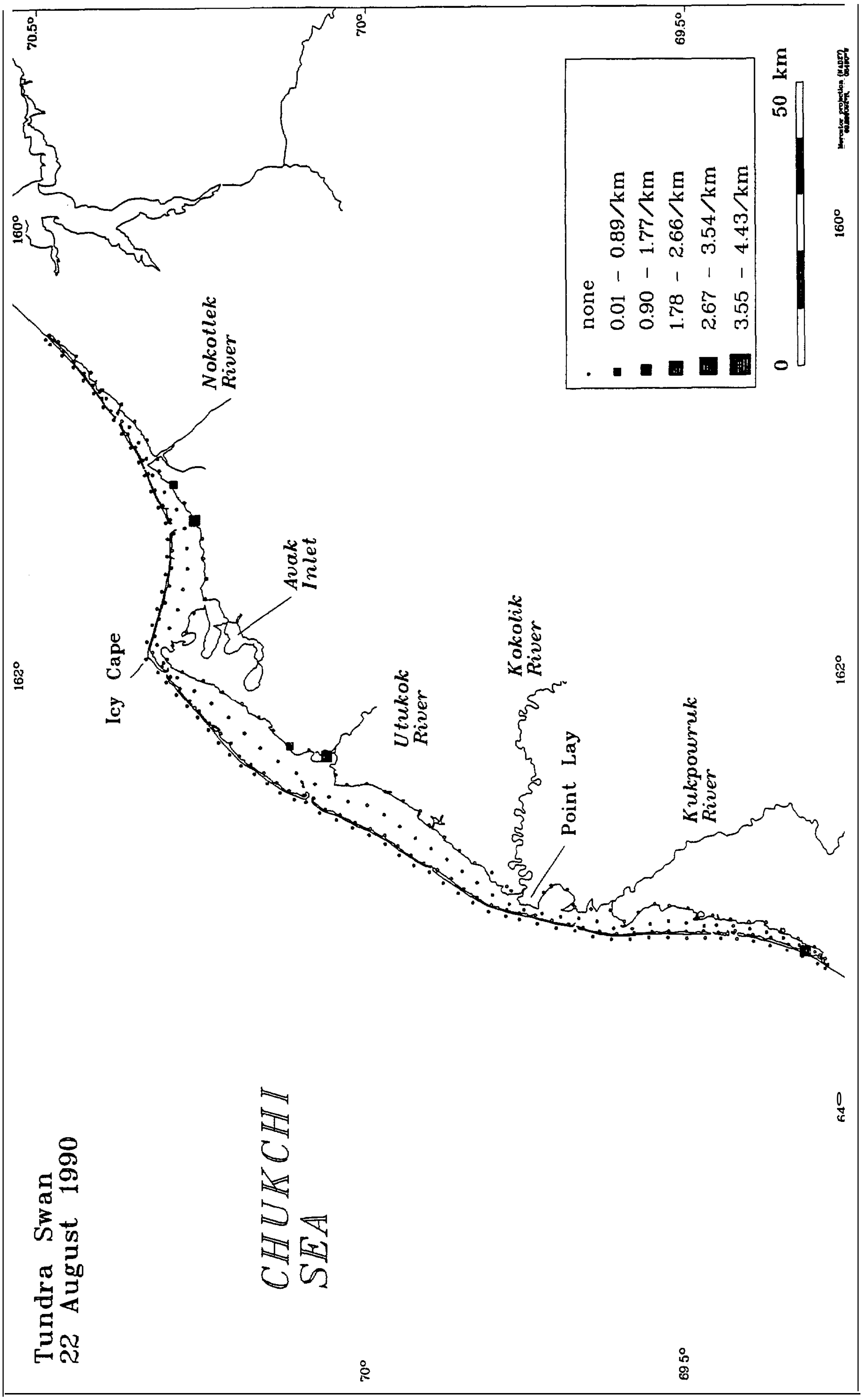
Tundra Swan
11 September 198
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 0.89/km
0.90 - 1.77/km
1.78 - 2.66/km
2.67 - 3.54/km
3.55 - 4.43/km
0
50 km
70.5°
70°
69.5°
162°
160°
164°

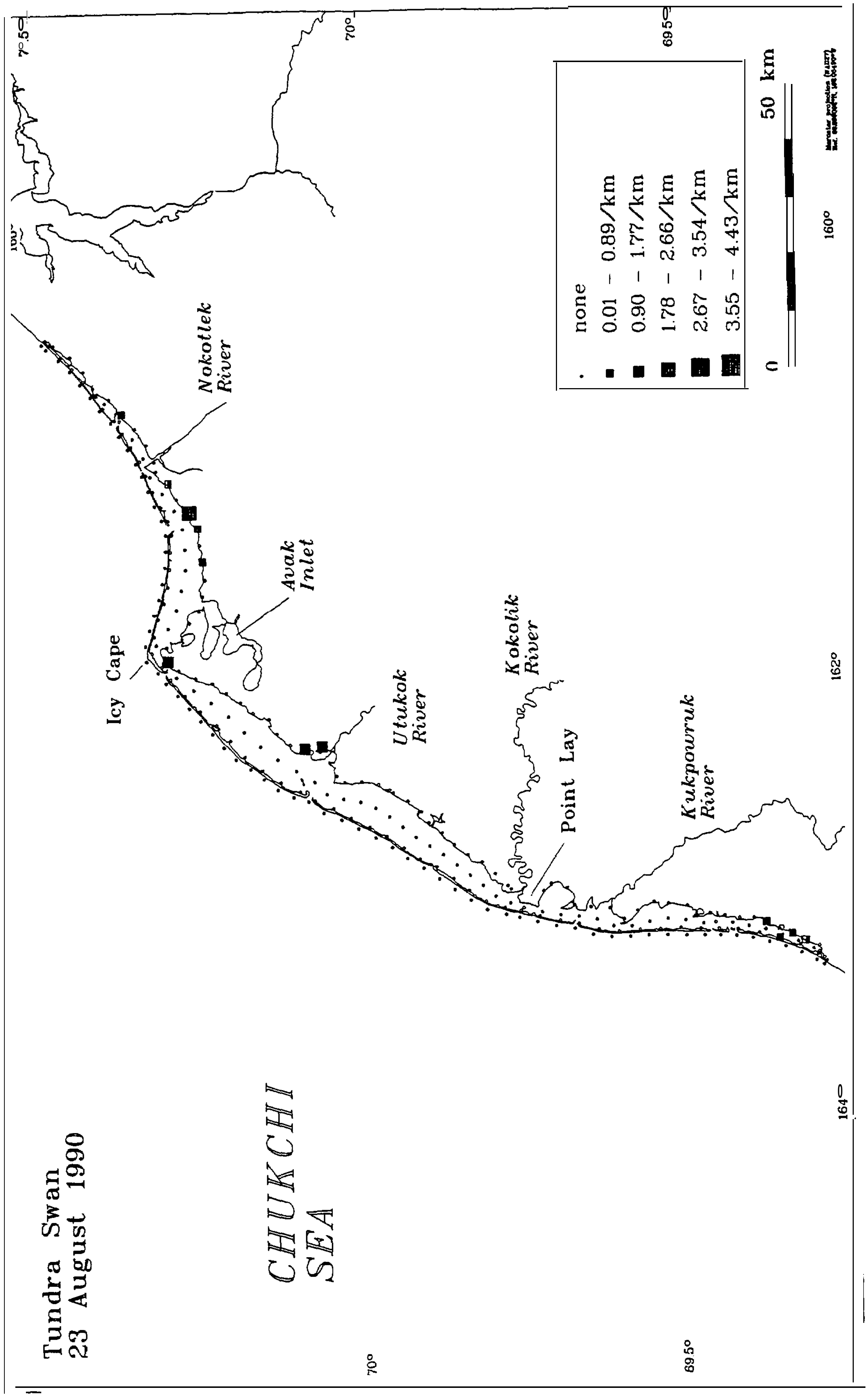

Tundra Swan
27 July 1990
CH UKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
160°
70.5°
70°
'70
.6950
69.5
164°
162°
160°
none
0.01 – 0.89/km
0.90 – 1.77/km
1.78 – 2.66/km
2.67 - 3.54/km
3.55- 4.43/km
0
50 km

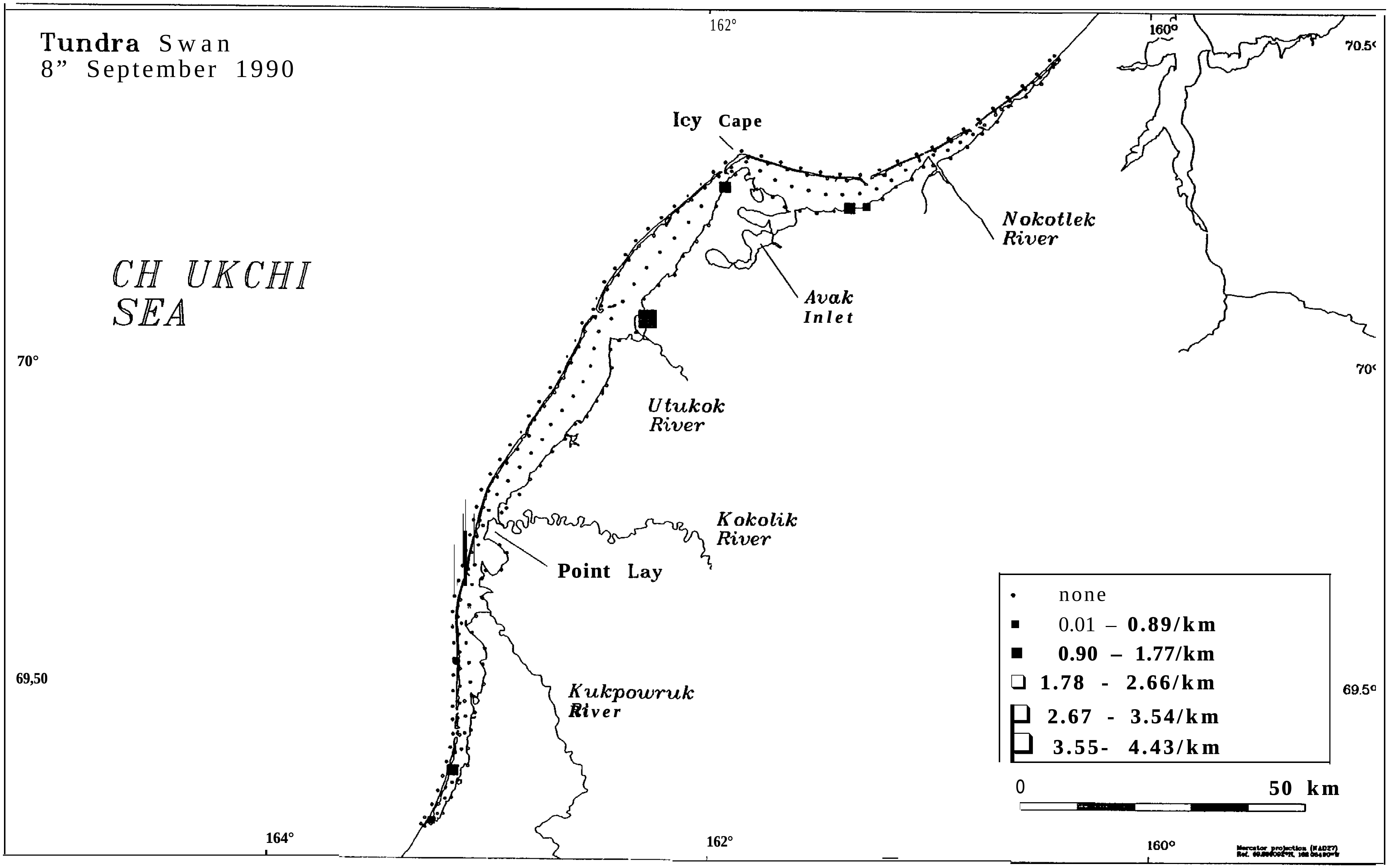

Tundra Swan
28 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 0.89/km
0.90 - 1.77/km
1.78 - 2.66/km
2.67 - 3.54/km
3.55 - 4.43/km
0
50 km
70°
69.5°
70°
69.5°
160°
162°
164°

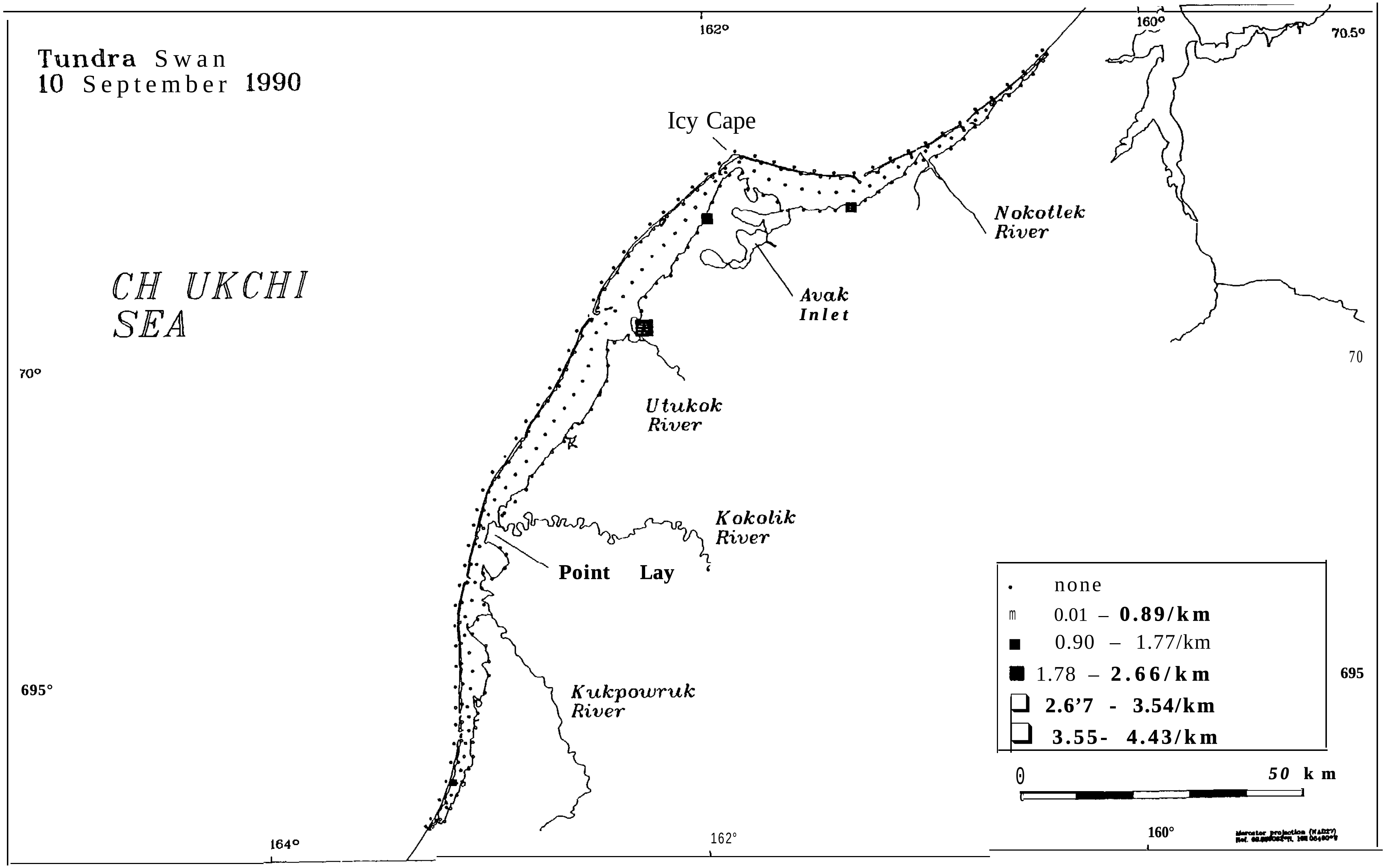

Tundra Swan
11 August 1990
1620
160°
70.5°
Icy cape
CH UKCHI SEA
70°
70'
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukp River
69.5
none
0.01 – 0.89/km
0.90 – 1.77/km
1.78 – 2.66/km
2.67 - 3.54/km
3.55- 4.43/km
0
50 km
160°

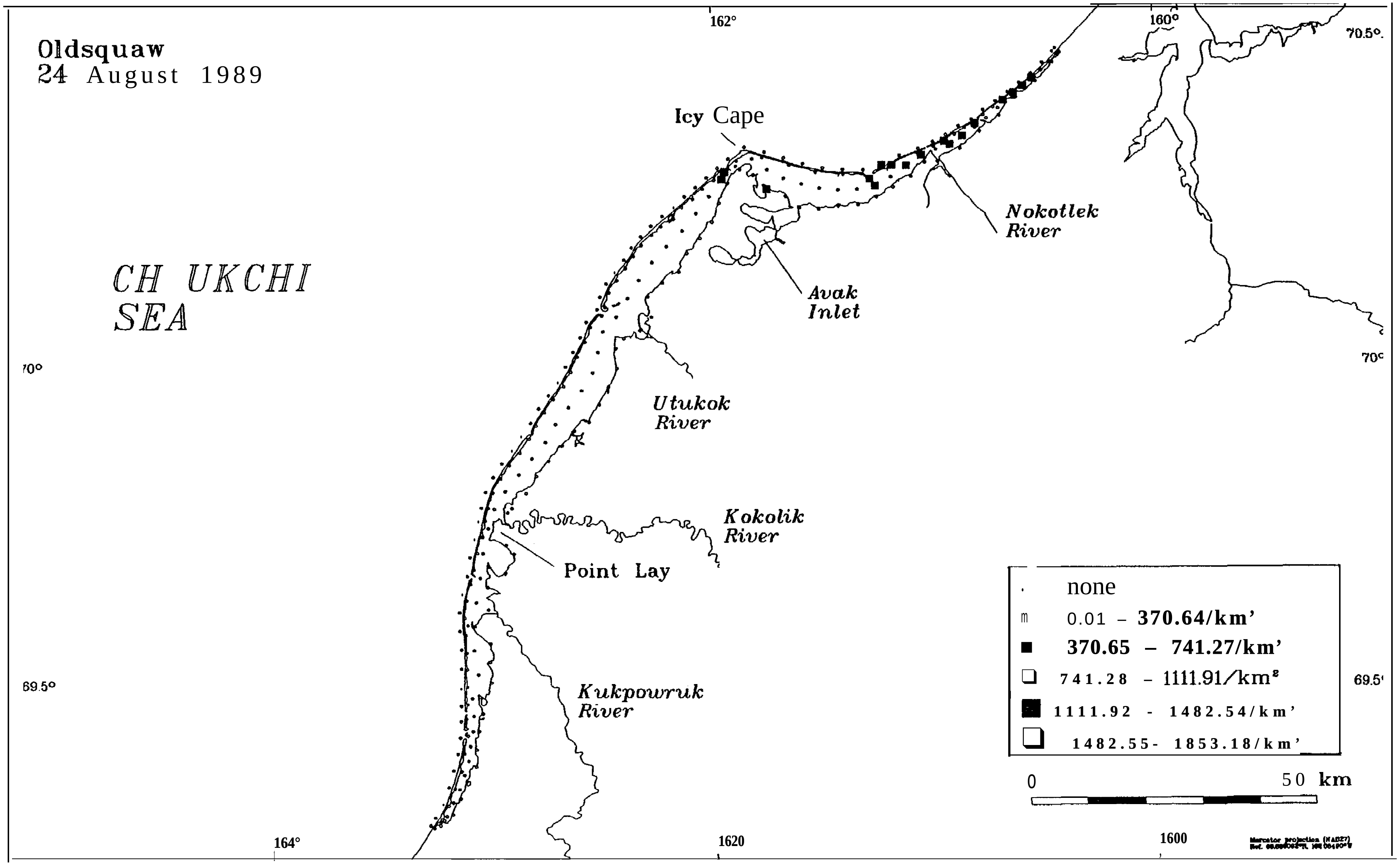

Tundra Swan
12 August 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.89/km
0.90 – 1.77/km
1.78 – 2.66/km
2.67 – 3.54/km
3.55 – 4.43/km
0
50 km
70°
69.5°
160°
162°


Tundra Swan
22 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 0.89/km
0.90 - 1.77/km
1.78 - 2.66/km
2.67 - 3.54/km
3.55 - 4.43/km
0
50 km
70.5°
70°
69.5°
160°
162°
64°
70°
69.5°
162°
160°


Tundra Swan
23 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 0.89/km
0.90 - 1.77/km
1.78 - 2.66/km
2.67 - 3.54/km
3.55 - 4.43/km
0
50 km
160°
162°
164°
70°
69.5°

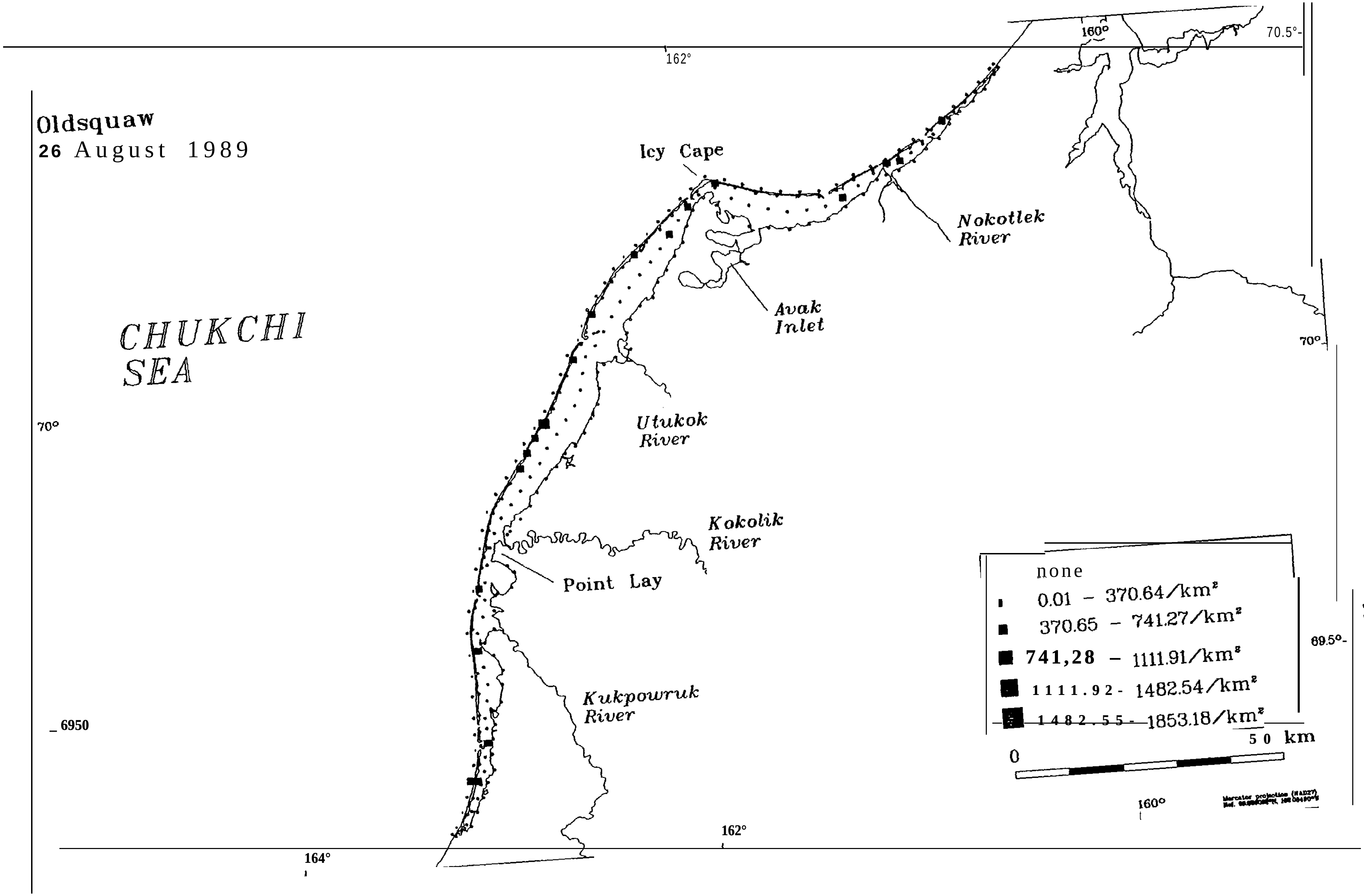

Tundra Swan
8" September 1990
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
• none
0.01 – 0.89/km
0.90 – 1.77/km
1.78 - 2.66/km
2.67 - 3.54/km
3.55- 4.43/km
0
50 km
162°
160°
164°
70.5°
70°
69,50
69.5°

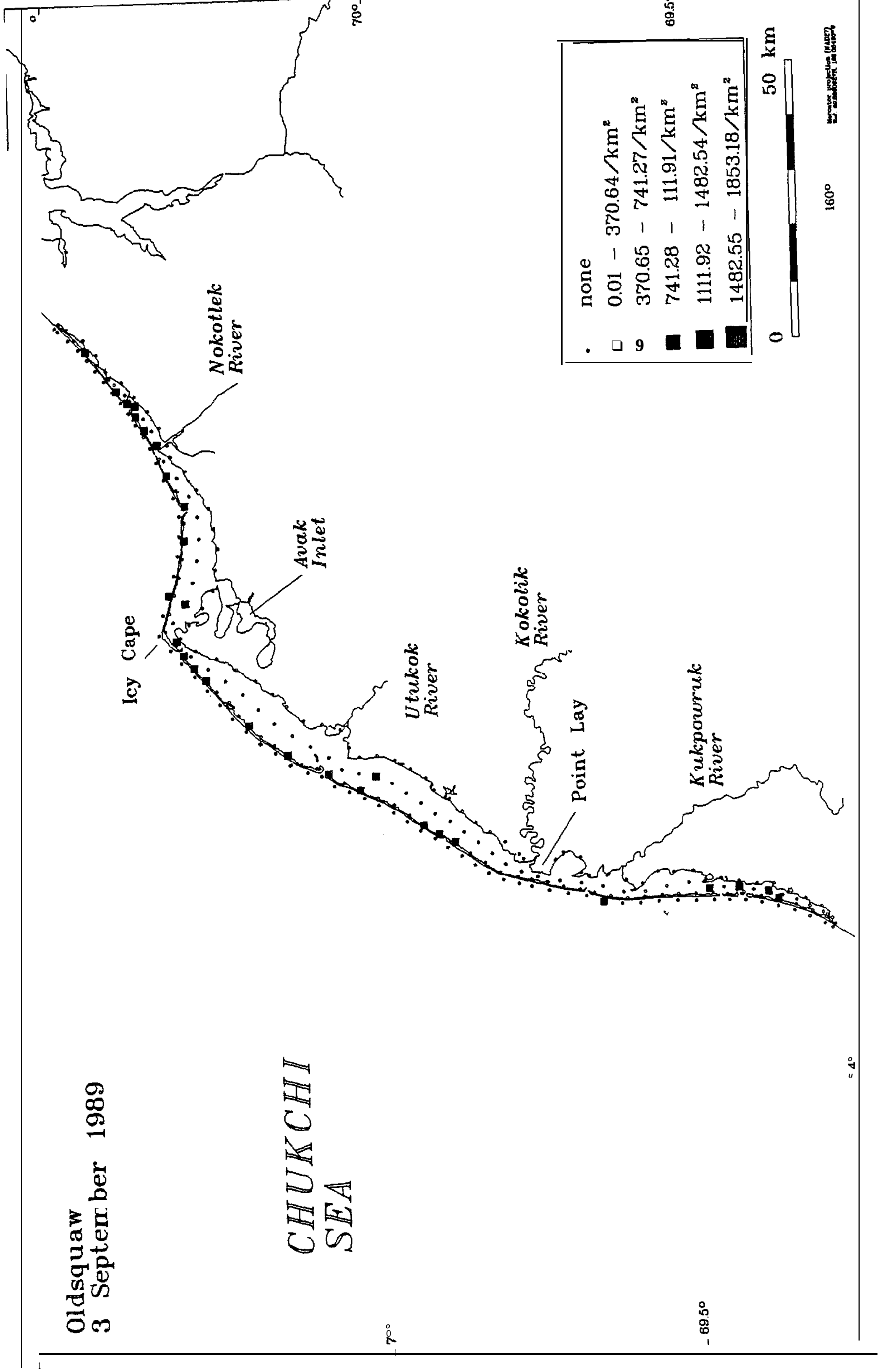

Tundra Swan
10 September 1990
Icy Cape
CH UKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70.5°
70°
70
695°
695
none
0.01 – 0.89/km
0.90 – 1.77/km
1.78 – 2.66/km
2.6'7 - 3.54/km
3.55- 4.43/km
0
50 km

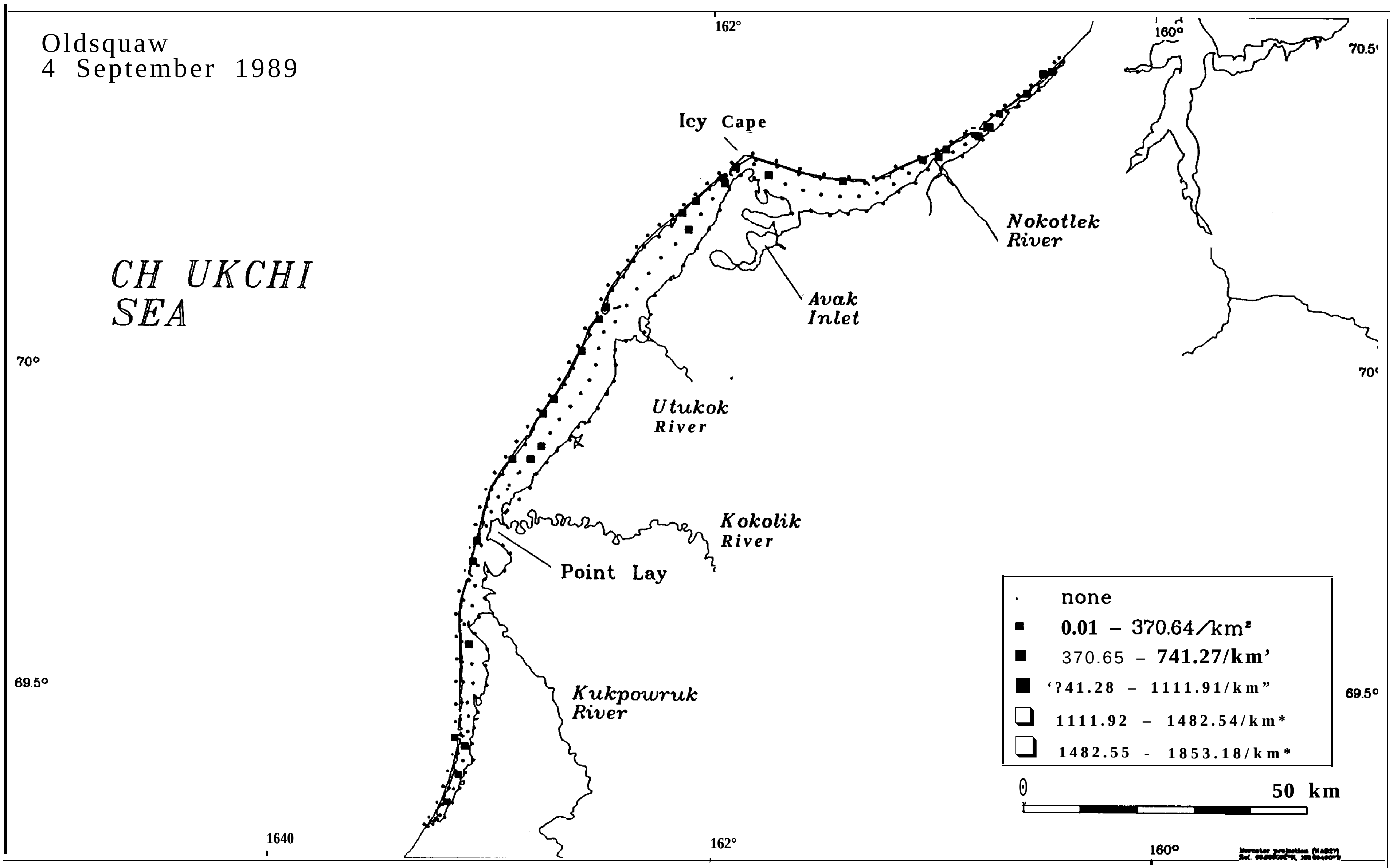


Oldsquaw
24 August 1989
Icy Cape
CH UKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
69.5°
164°
1620
1600
none
0.01 – 370.64/km'
370.65 – 741.27/km'
741.28 – 1111.91/km²
1111.92 - 1482.54/km'
1482.55- 1853.18/km'
0
50 km

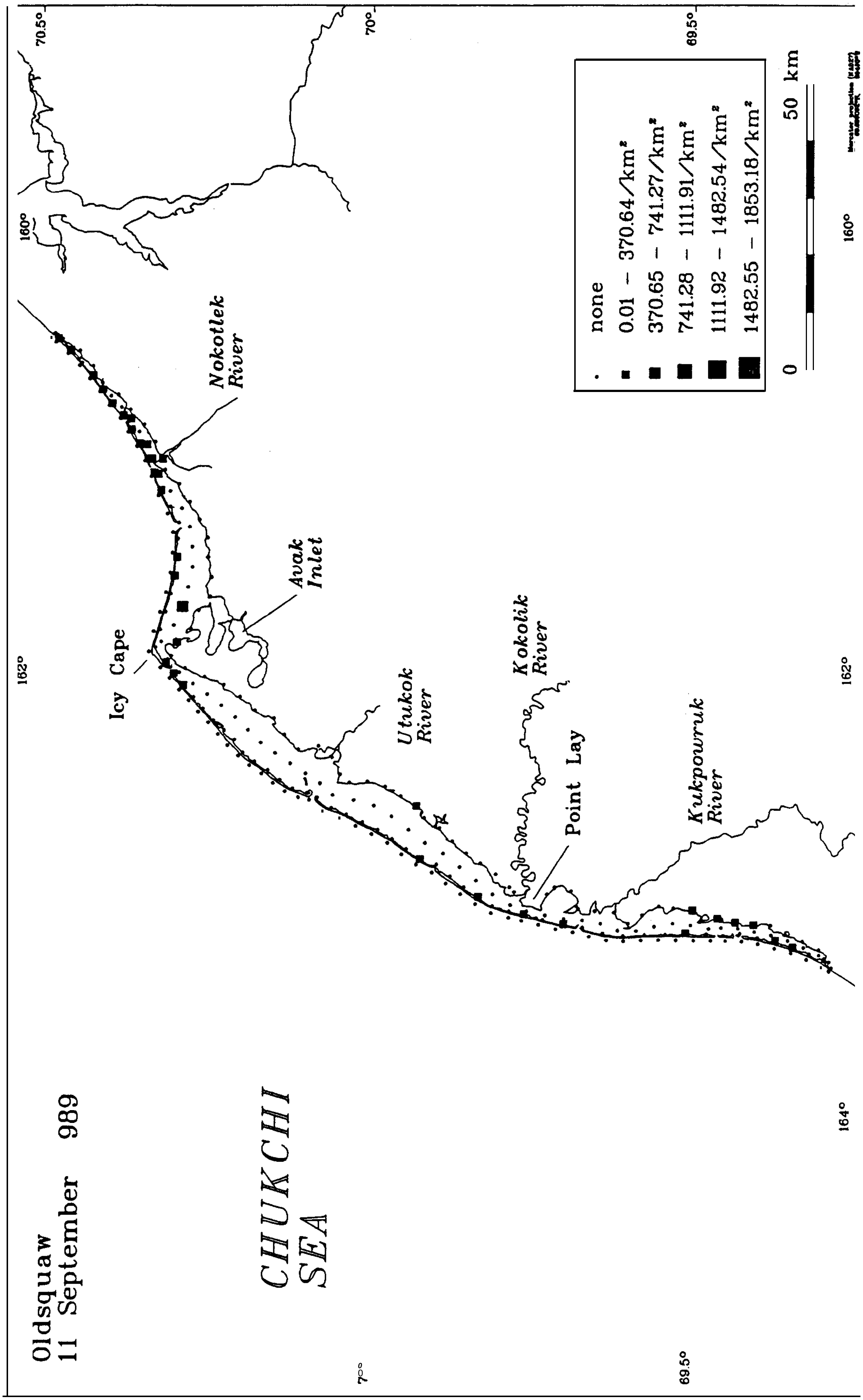
Oldsquaw
26 August 1989

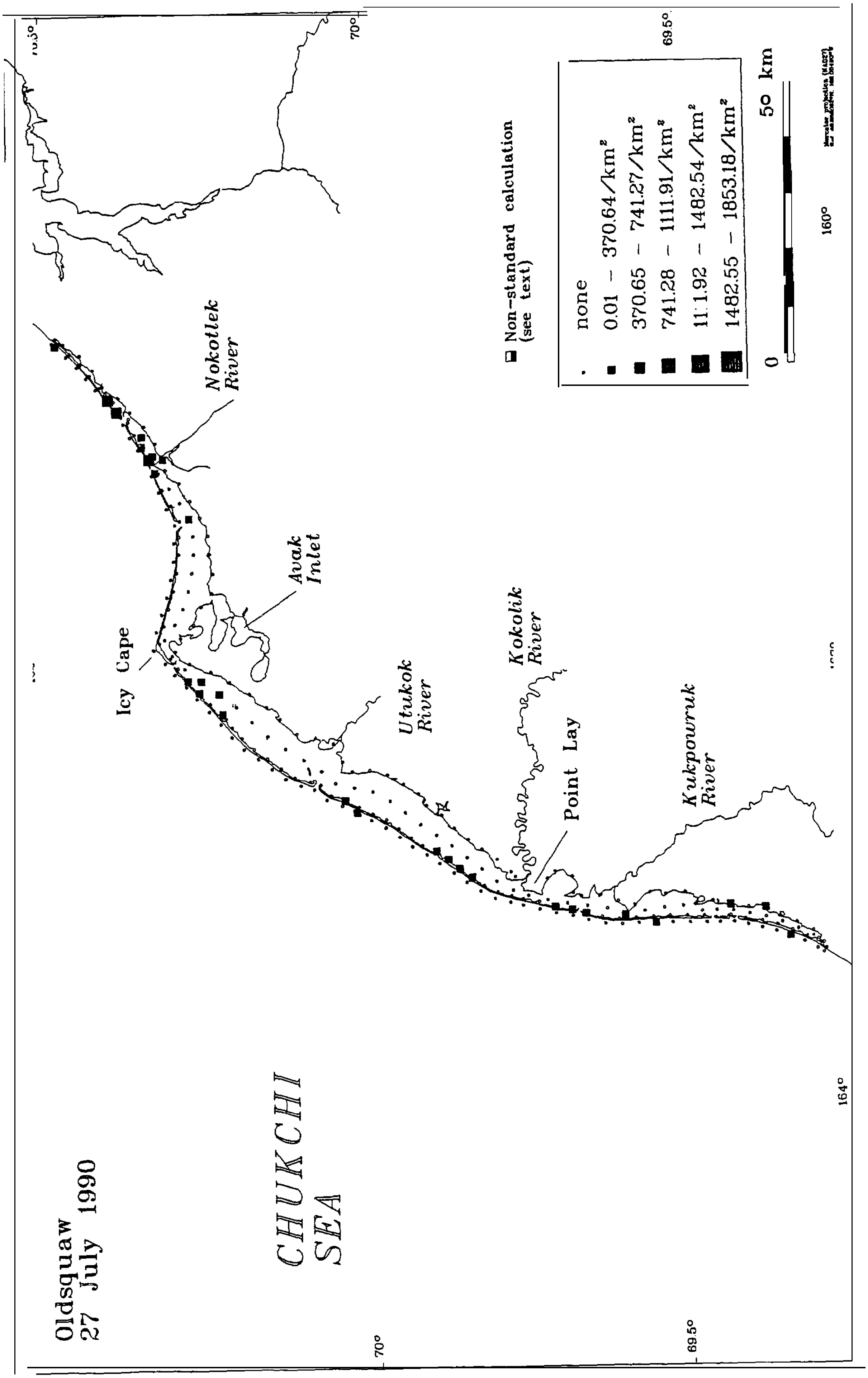


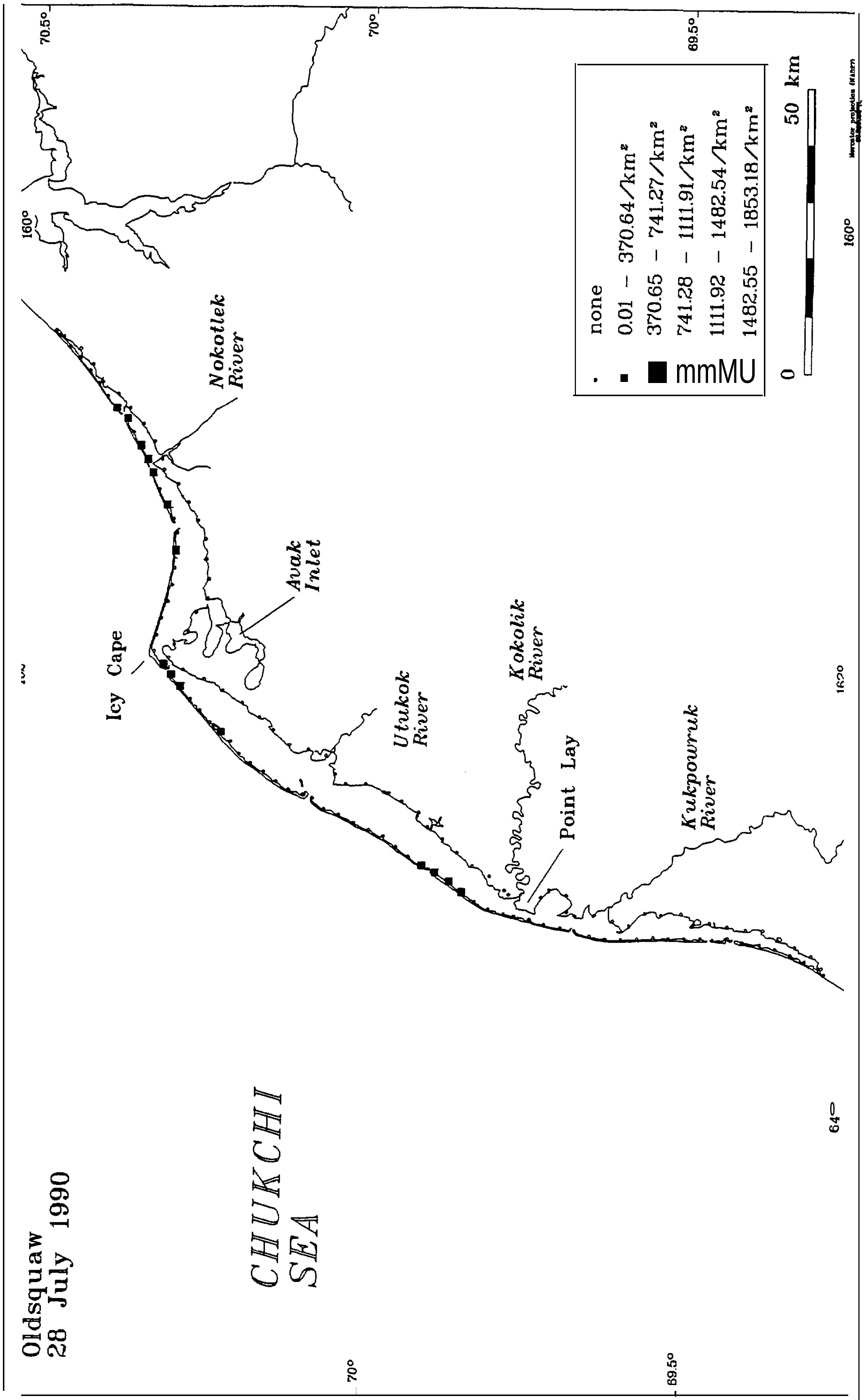

Oldsquaw
3 September 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 370.64/km²
370.65 - 741.27/km²
741.28 - 111.91/km²
1111.92 - 1482.54/km²
1482.55 - 1853.18/km²
0
50 km
70°
69.5°
160°

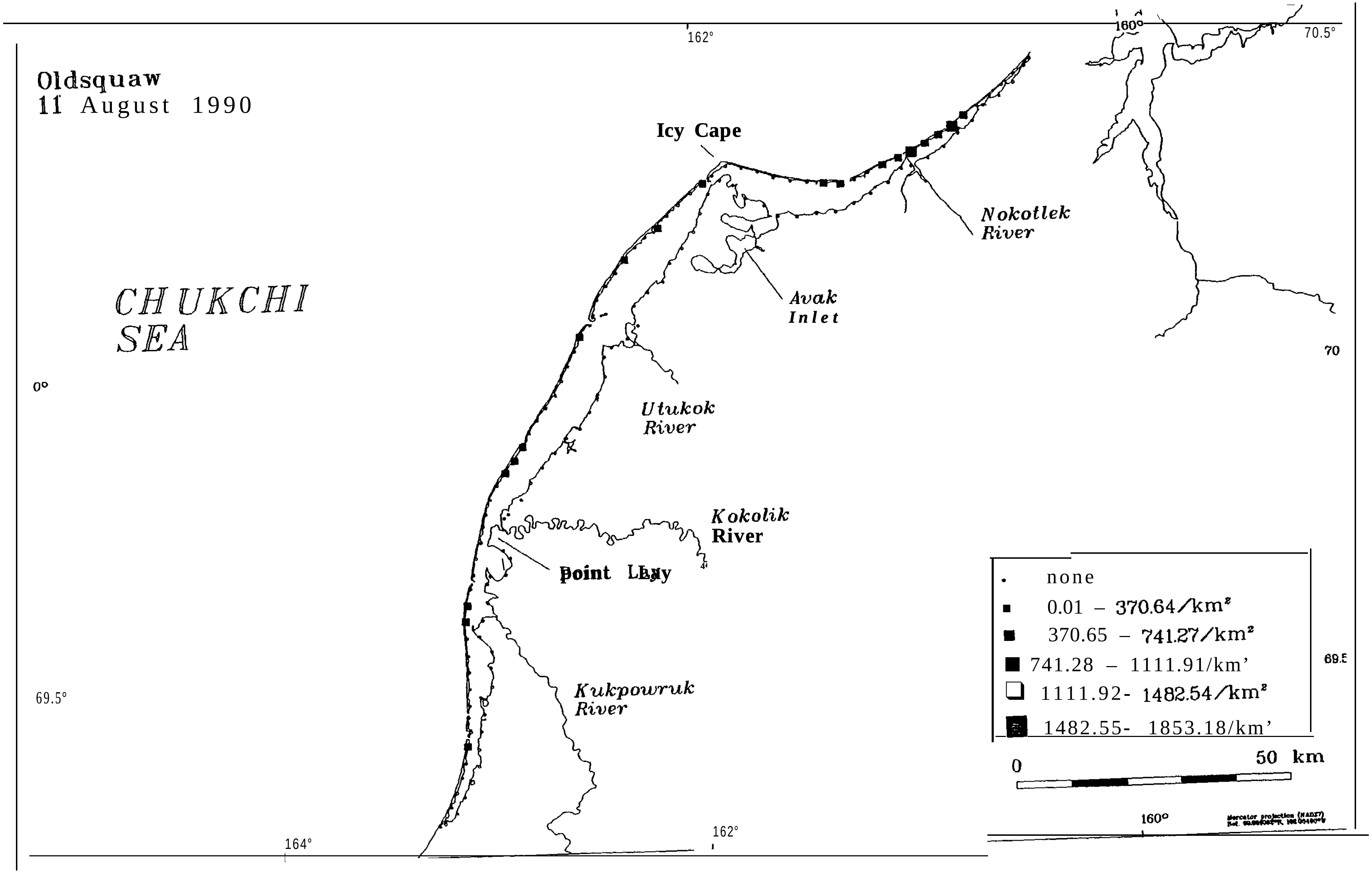


Oldsquaw
4 September 1989
162°
160°
70.5°
Icy Cape
Nokotlek River
CH UKCHI SEA
Avak Inlet
70°
70°
Utukok River
Kokolik River
Point Lay
none
0.01 – 370.64/km²
370.65 – 741.27/km²
741.28 – 1111.91/km²
1111.92 – 1482.54/km²
1482.55 - 1853.18/km²
69.5°
69.5°
Kukpowruk River
0
50 km
164°
162°
160°

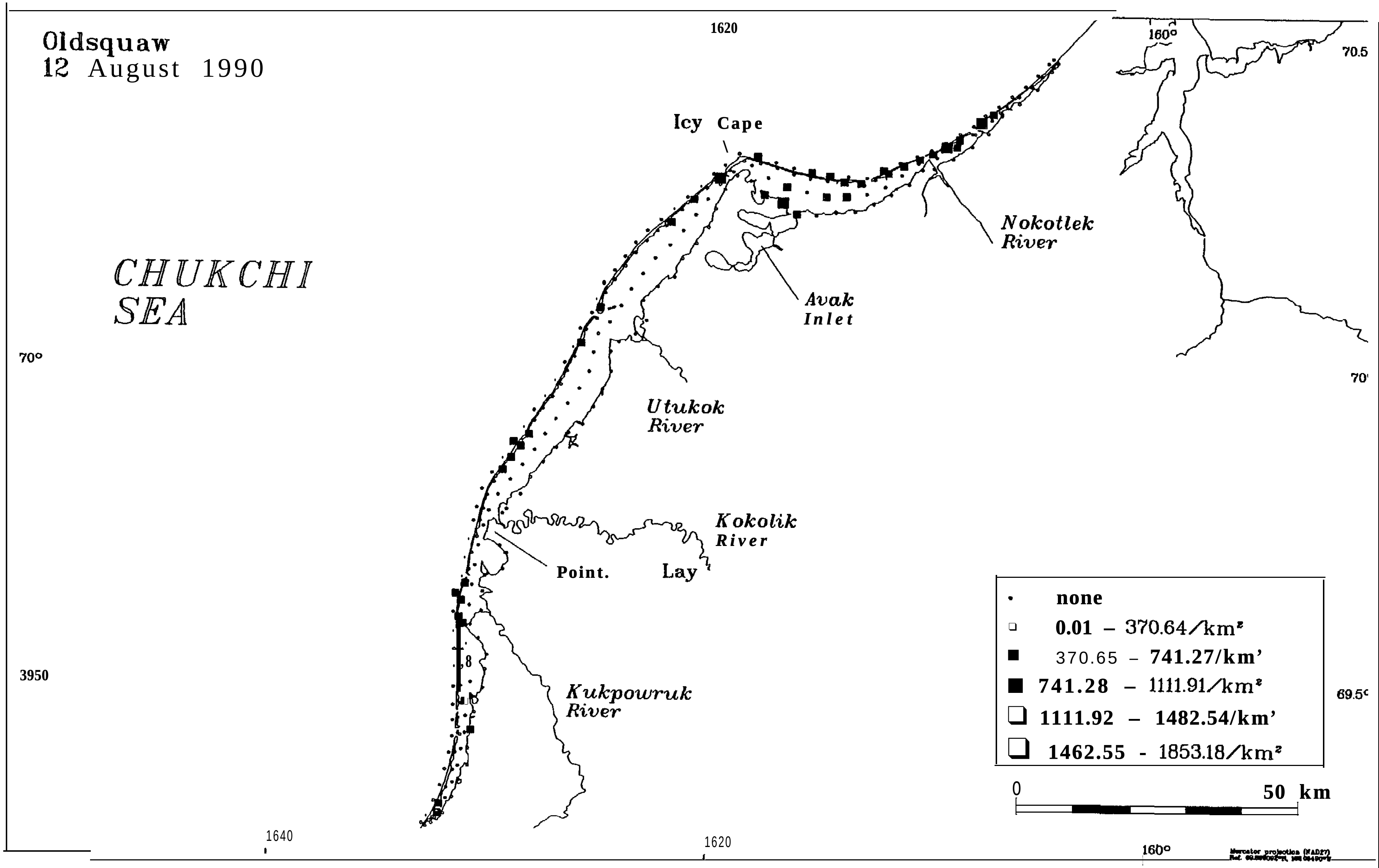

Oldsquaw
11 September 989
CHUKCHI
SEA
Icy Cape
Avak
Inlet
Nokotlek
River
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 370.64/km²
370.65 - 741.27/km²
741.28 - 1111.91/km²
1111.92 - 1482.54/km²
1482.55 - 1853.18/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

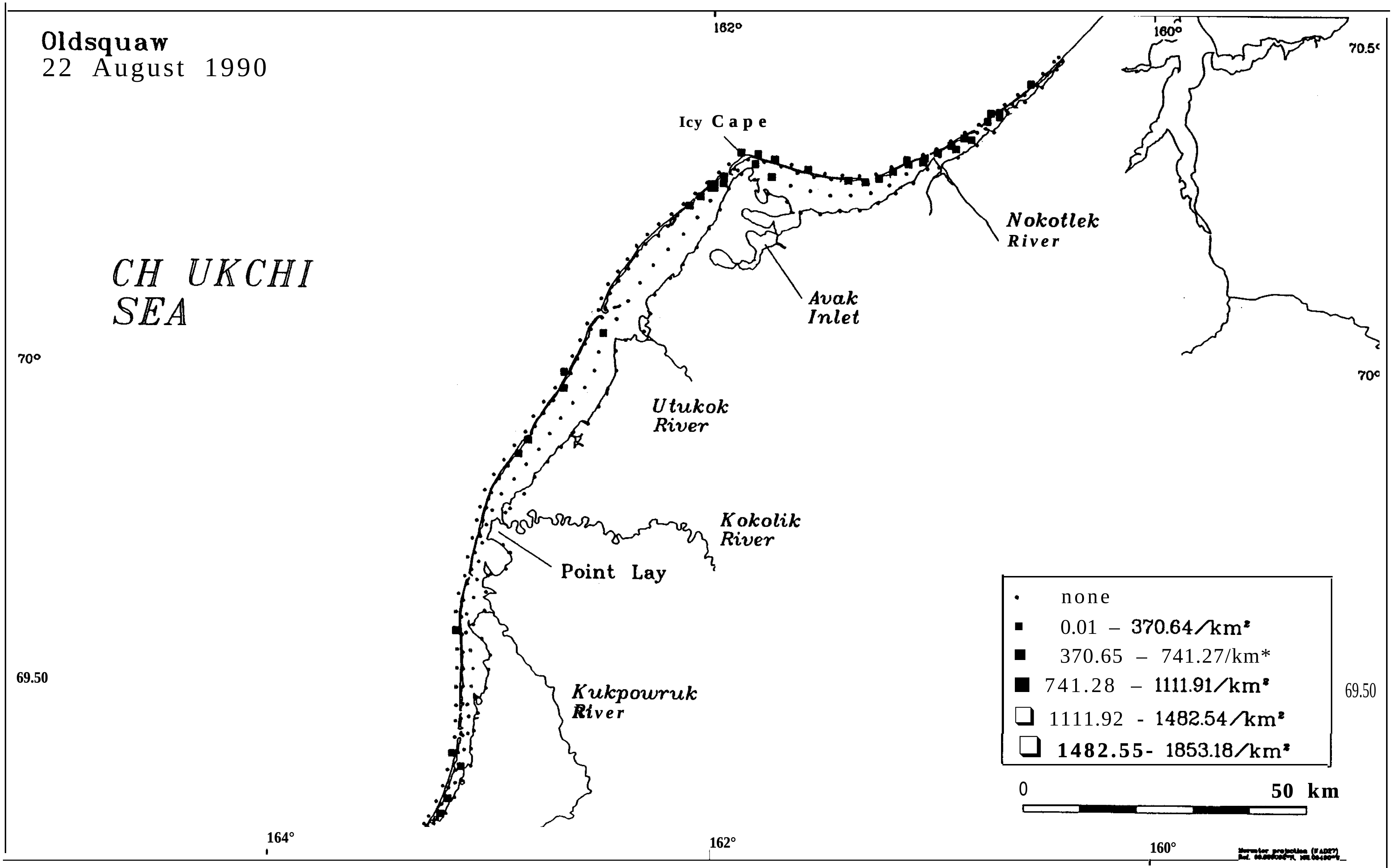

Oldsquaw
27 July 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
Non-standard calculation
(see text)
none
0.01 - 370.64/km²
370.65 - 741.27/km²
741.28 - 1111.91/km²
1111.92 - 1482.54/km²
1482.55 - 1853.18/km²
0
50 km
70°
69.5°
164°
160°

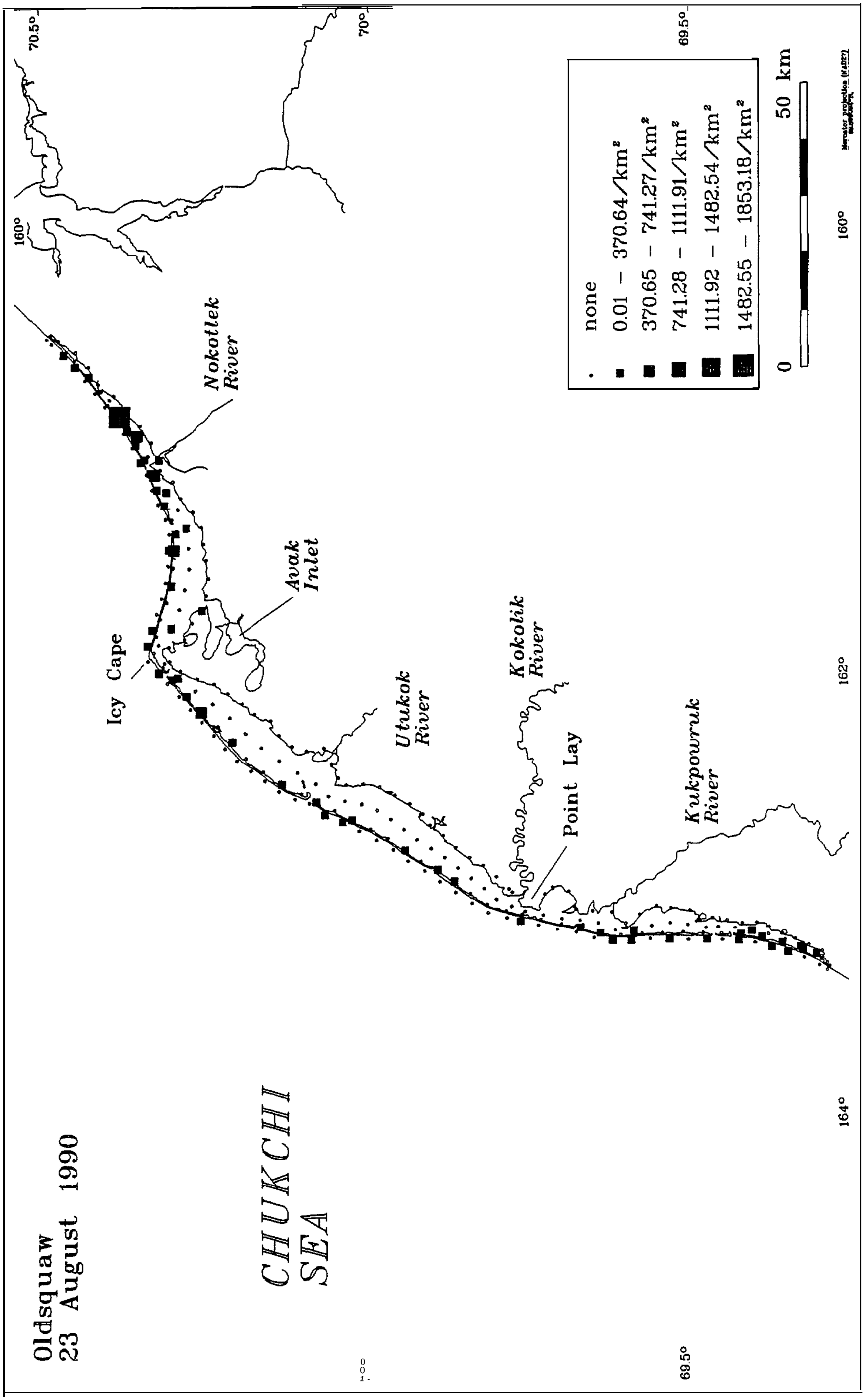

Oldsquaw
28 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 370.64/km²
370.65 – 741.27/km²
741.28 – 1111.91/km²
1111.92 – 1482.54/km²
1482.55 – 1853.18/km²
mmMU
0
50 km
70.5°
70°
69.5°
160°

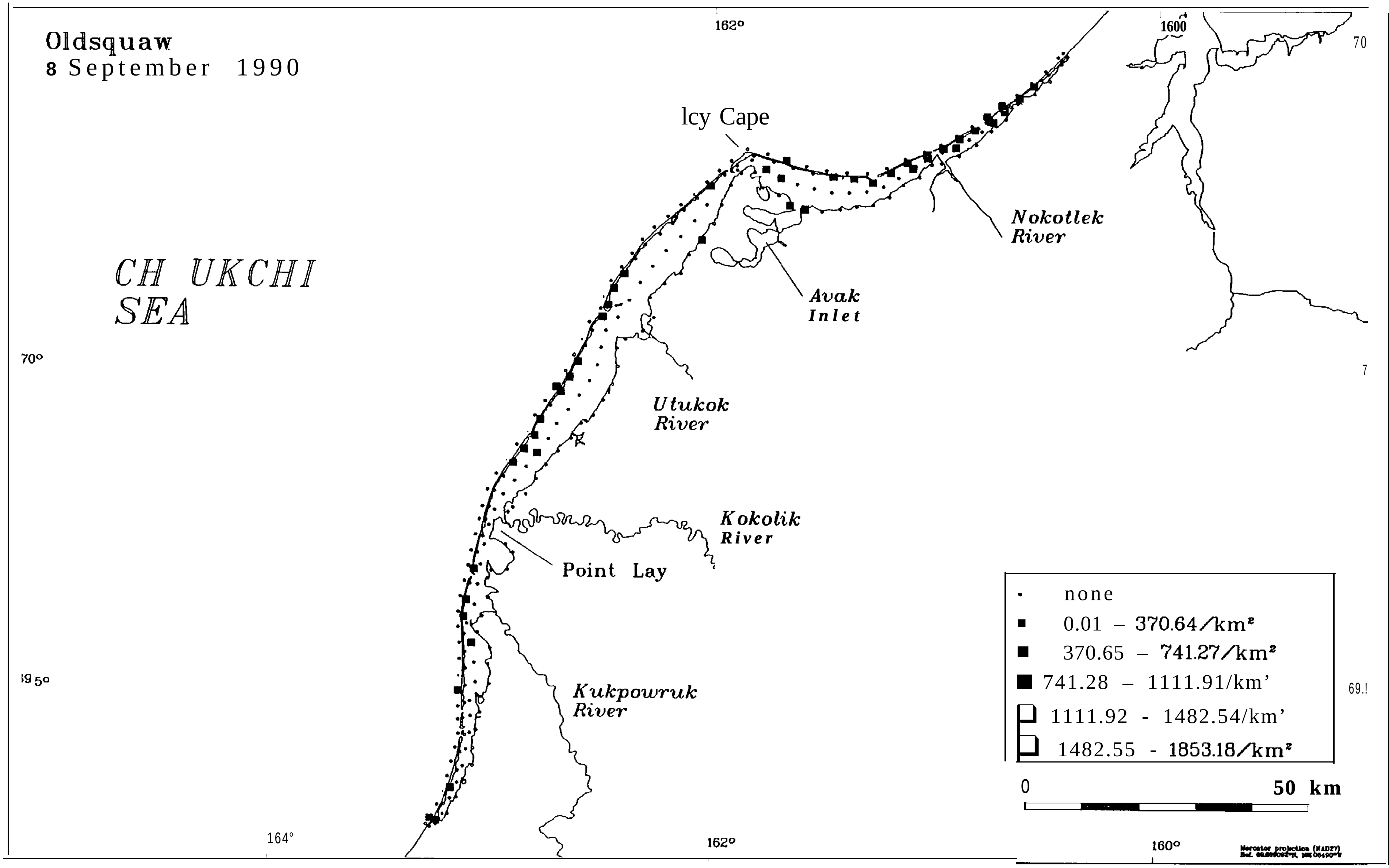


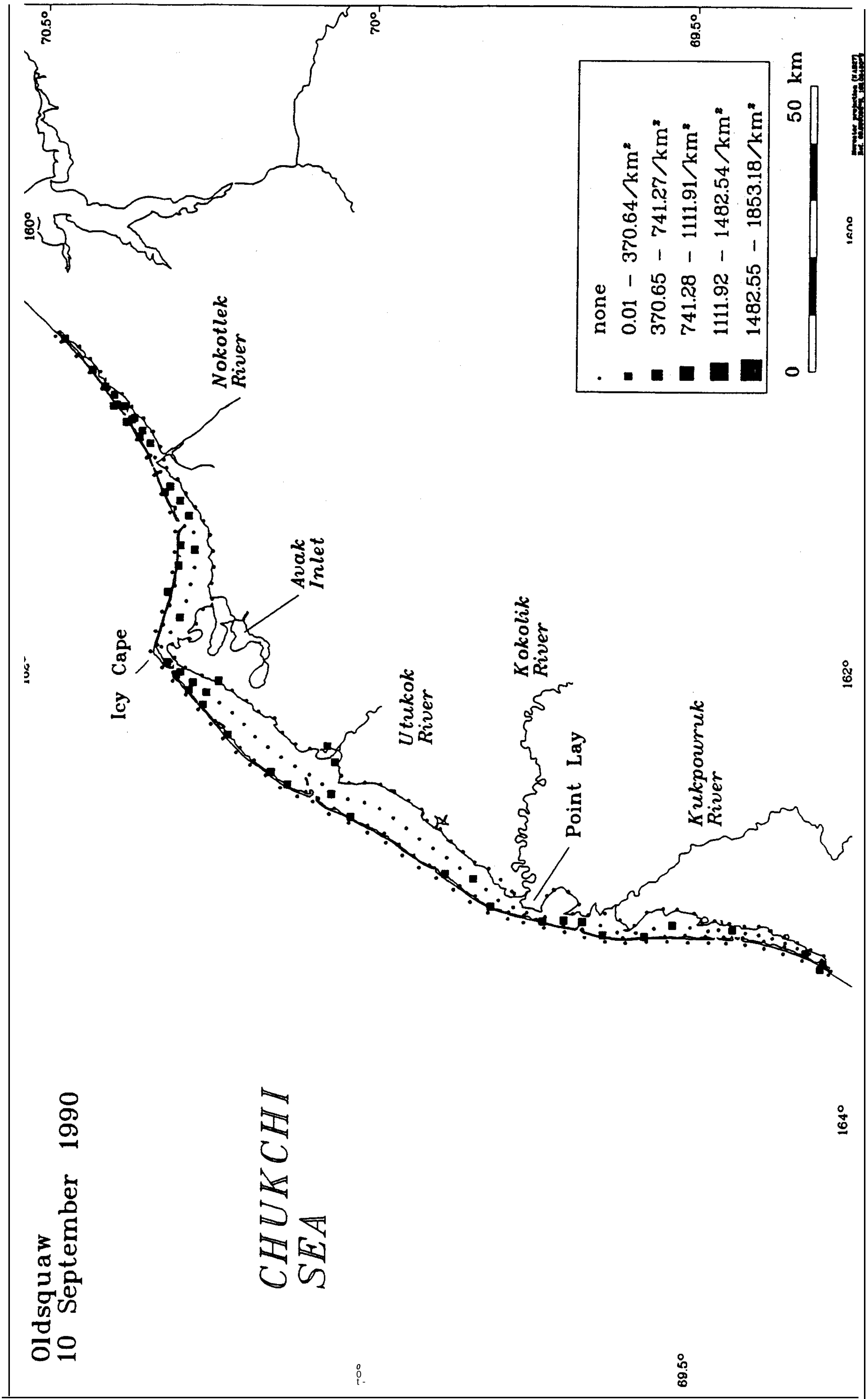
Oldsquaw
11 August 1990
Icy Cape
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 370.64/km²
370.65 – 741.27/km²
741.28 – 1111.91/km'
1111.92- 1482.54/km²
1482.55- 1853.18/km'
0
50 km
162°
160°
70.5°
70
69.5
69.5°
164°
162°
160°

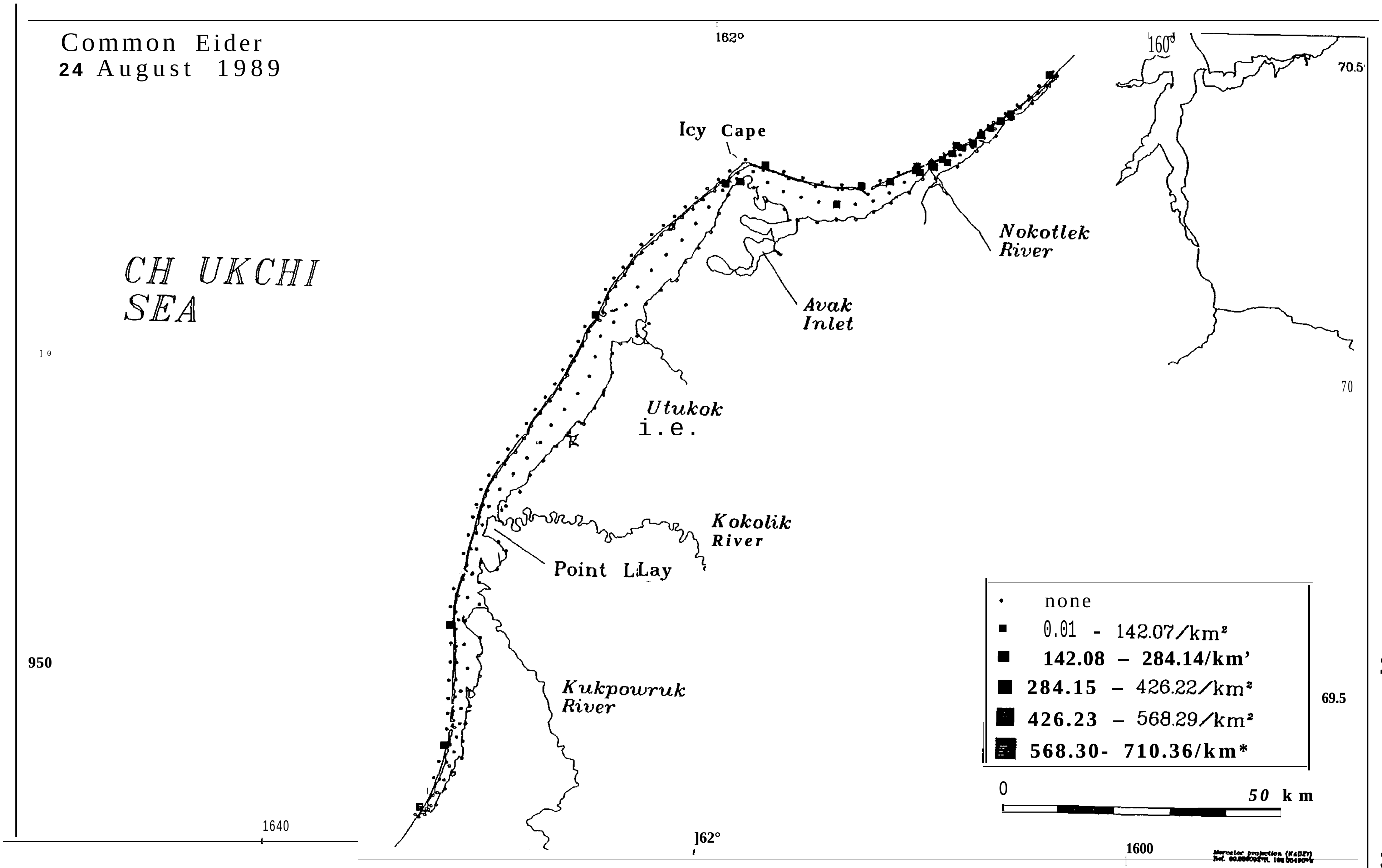

Oldsquaw
12 August 1990
1620
160°
70.5
Icy Cape
Nokotlek River
Avak Inlet
CHUKCHI SEA
70°
70'
Utukok River
Kokolik River
Point. Lay
Kukpowruk River
3950
69.5°
none
0.01 – 370.64/km²
370.65 – 741.27/km'
741.28 – 1111.91/km²
1111.92 – 1482.54/km'
1462.55 - 1853.18/km²
0
50 km
1640
1620
160°


Oldsquaw
22 August 1990
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70.5°
70°
69.50
none
0.01 – 370.64/km²
370.65 – 741.27/km*
741.28 – 1111.91/km²
1111.92 - 1482.54/km²
1482.55- 1853.18/km²
0
50 km

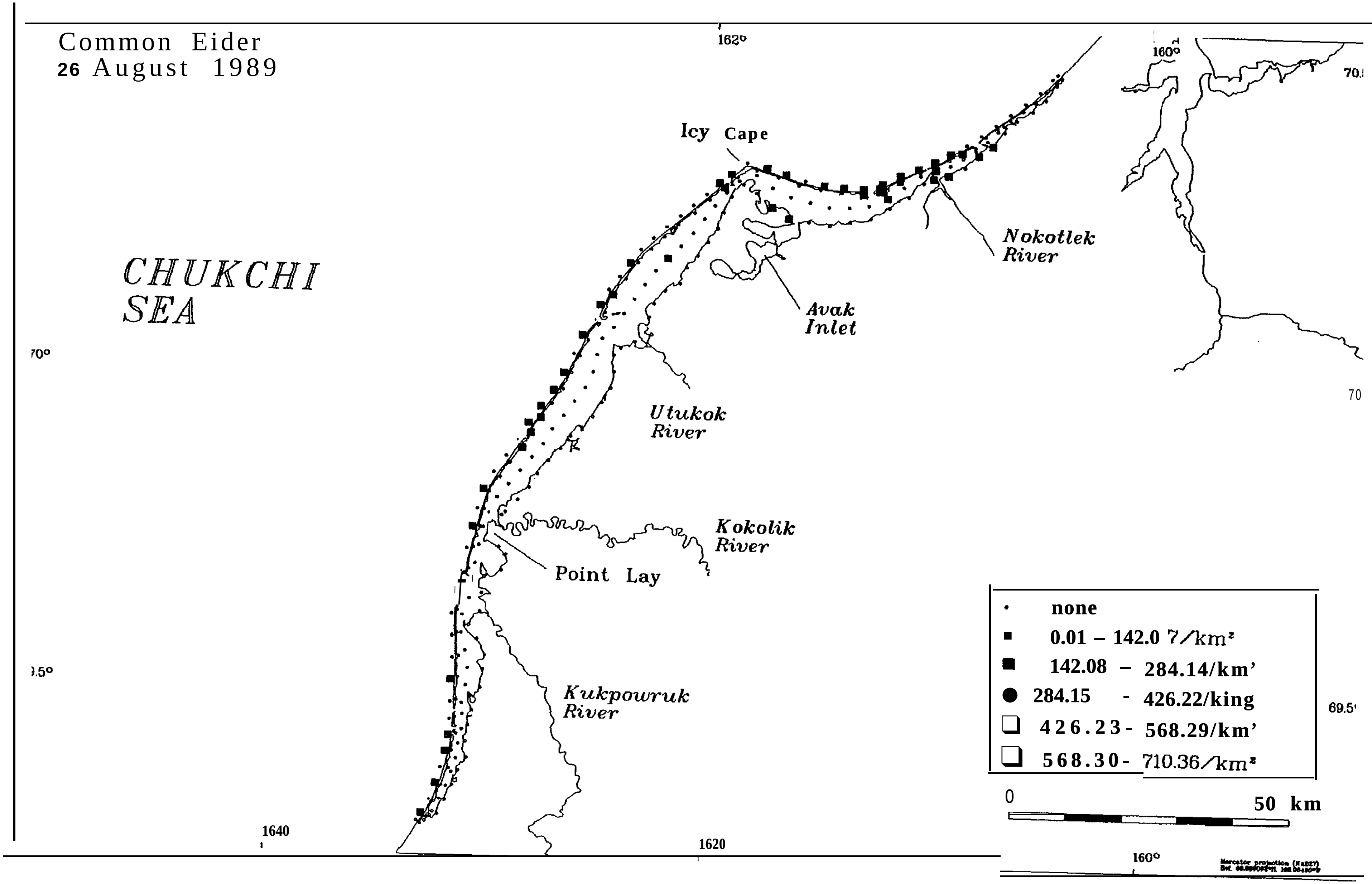

Oldsquaw
23 August 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 370.64/km²
370.65 – 741.27/km²
741.28 – 1111.91/km²
1111.92 – 1482.54/km²
1482.55 – 1853.18/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

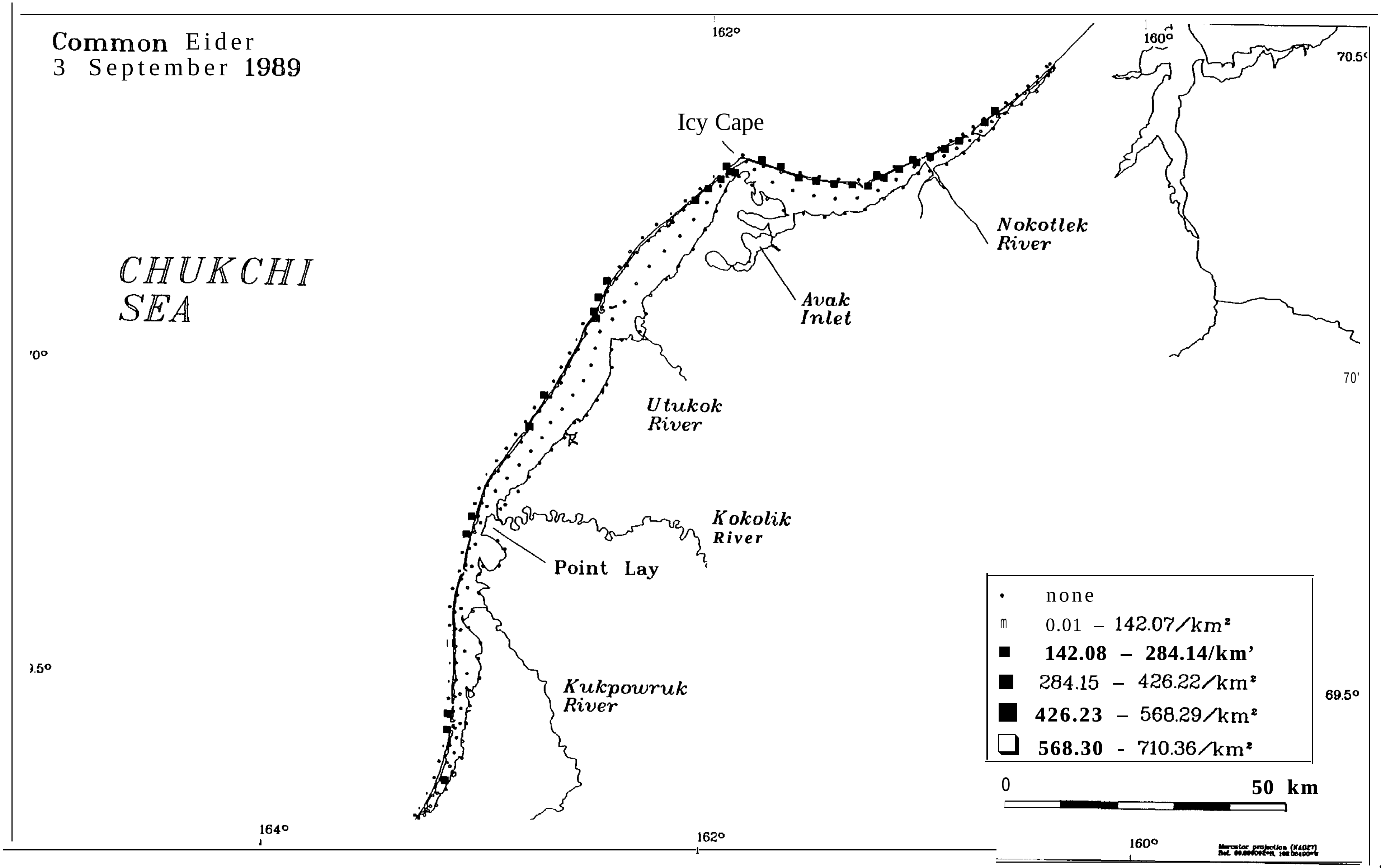

Oldsquaw
8 September 1990
Icy Cape
CHUKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 370.64/km²
370.65 – 741.27/km²
741.28 – 1111.91/km²
1111.92 - 1482.54/km²
1482.55 - 1853.18/km²
0
50 km
162°
160°
164°
70°
69.5°

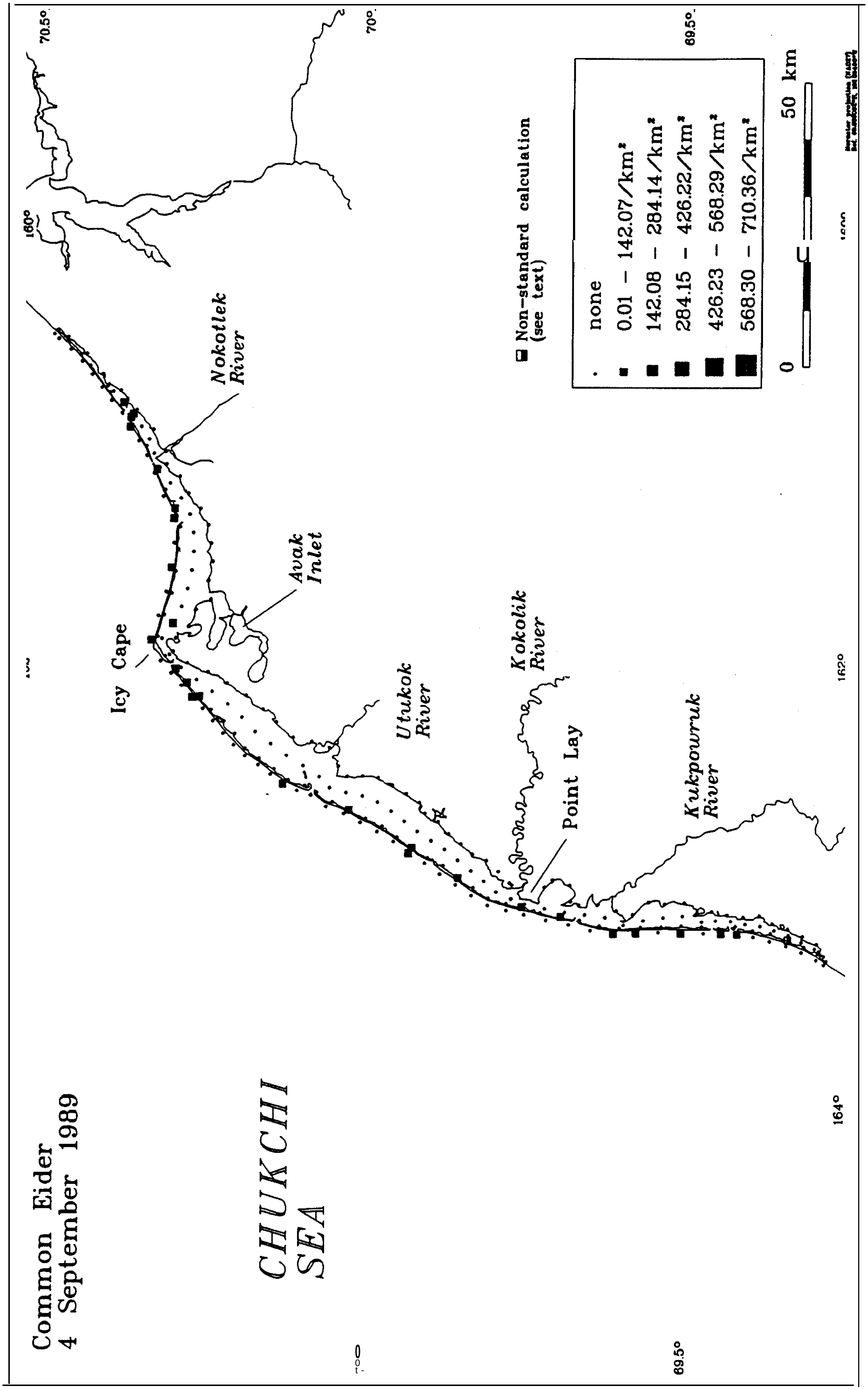

Oldsquaw
10 September 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 370.64/km²
370.65 – 741.27/km²
741.28 – 1111.91/km²
1111.92 – 1482.54/km²
1482.55 – 1853.18/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°
69.5°

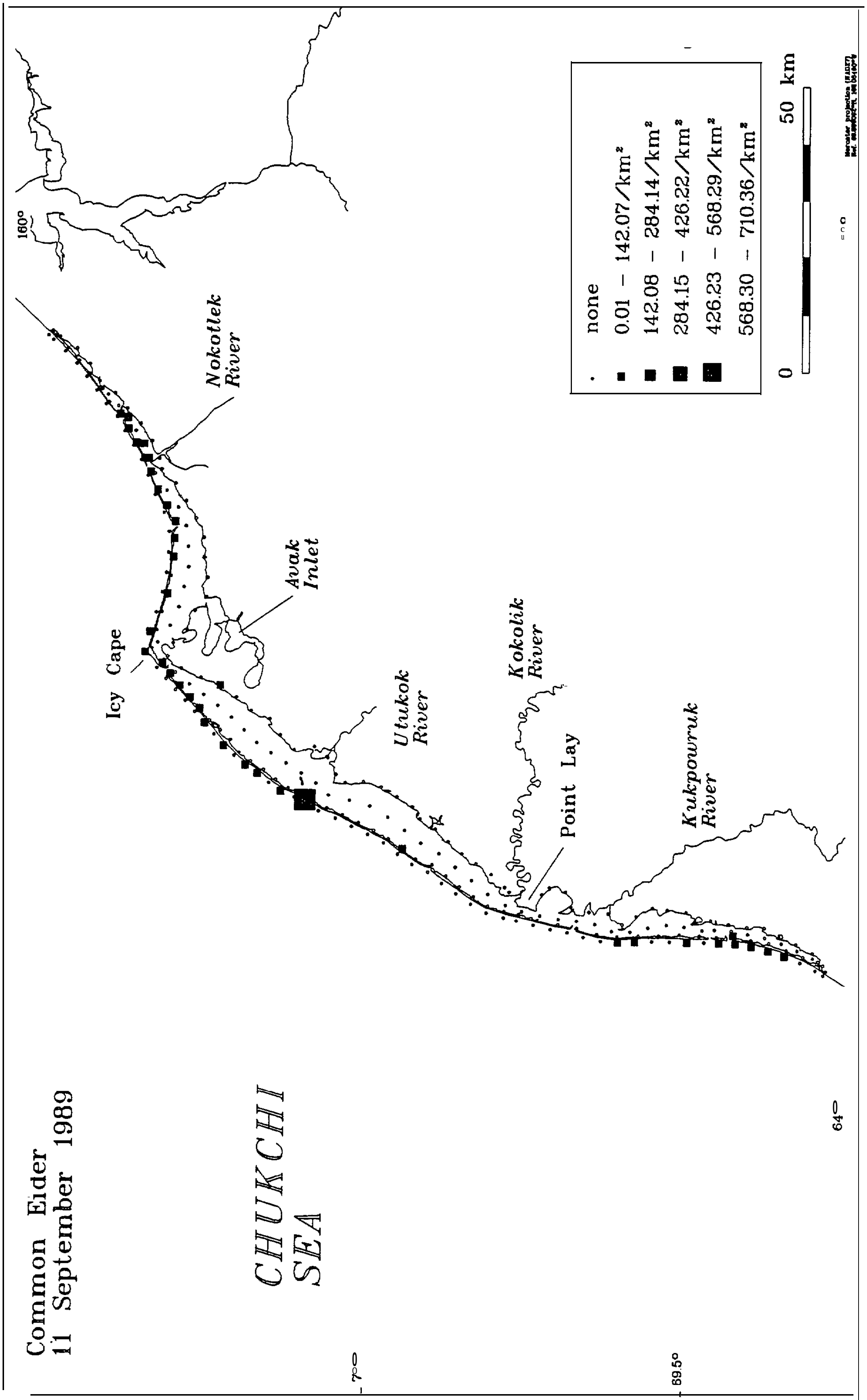

Common Eider
24 August 1989
162°
160°
70.5
Icy Cape
CHUKCHI SEA
Nokotlek River
Avak Inlet
Utukok
70
Kokolik River
Point Lay
none
0.01 - 142.07/km²
142.08 - 284.14/km²
284.15 - 426.22/km²
426.23 - 568.29/km²
568.30- 710.36/km*
950
Kukpowruk River
69.5
0
50 km
1640
162°
1600

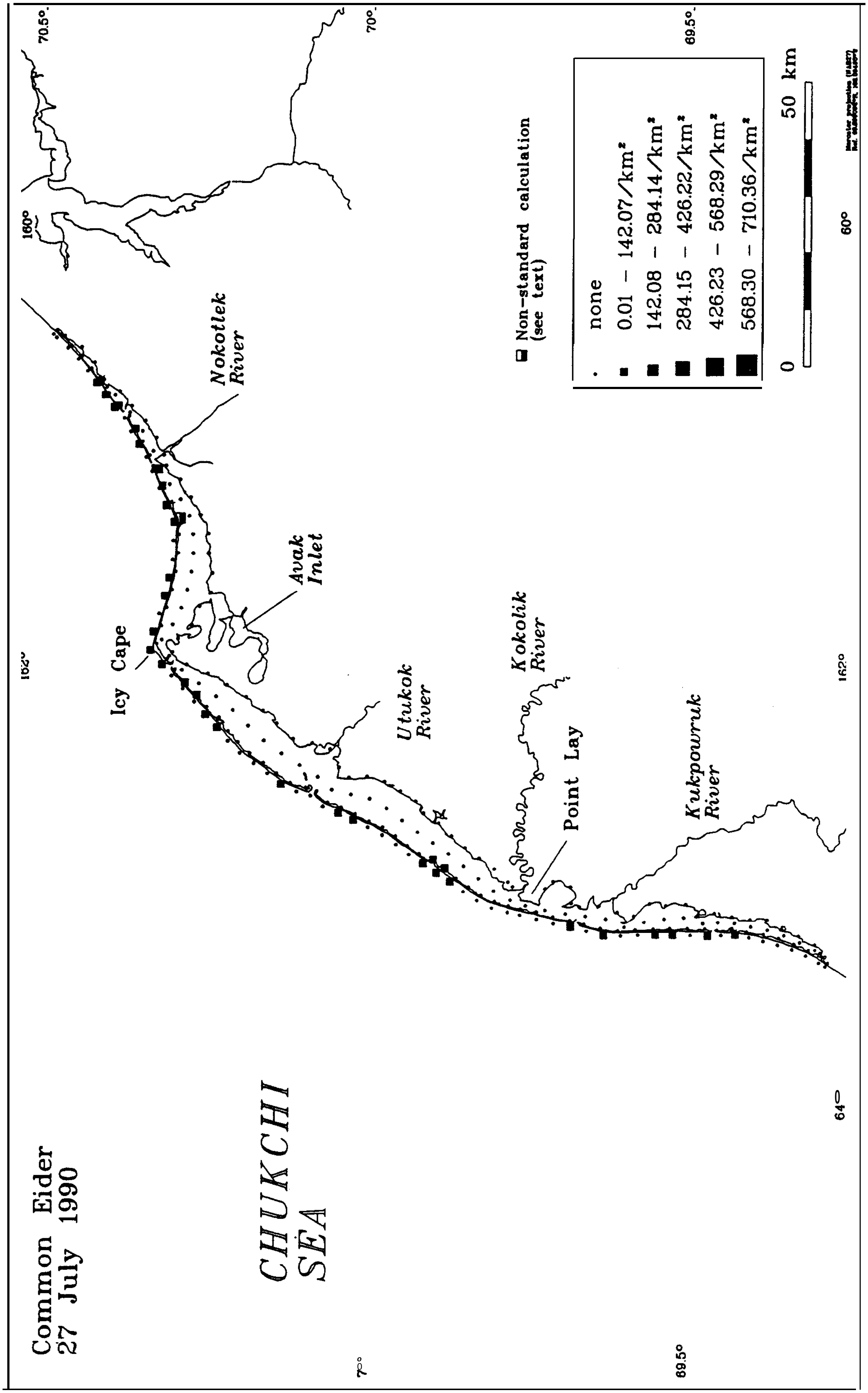
Common Eider
26 August 1989



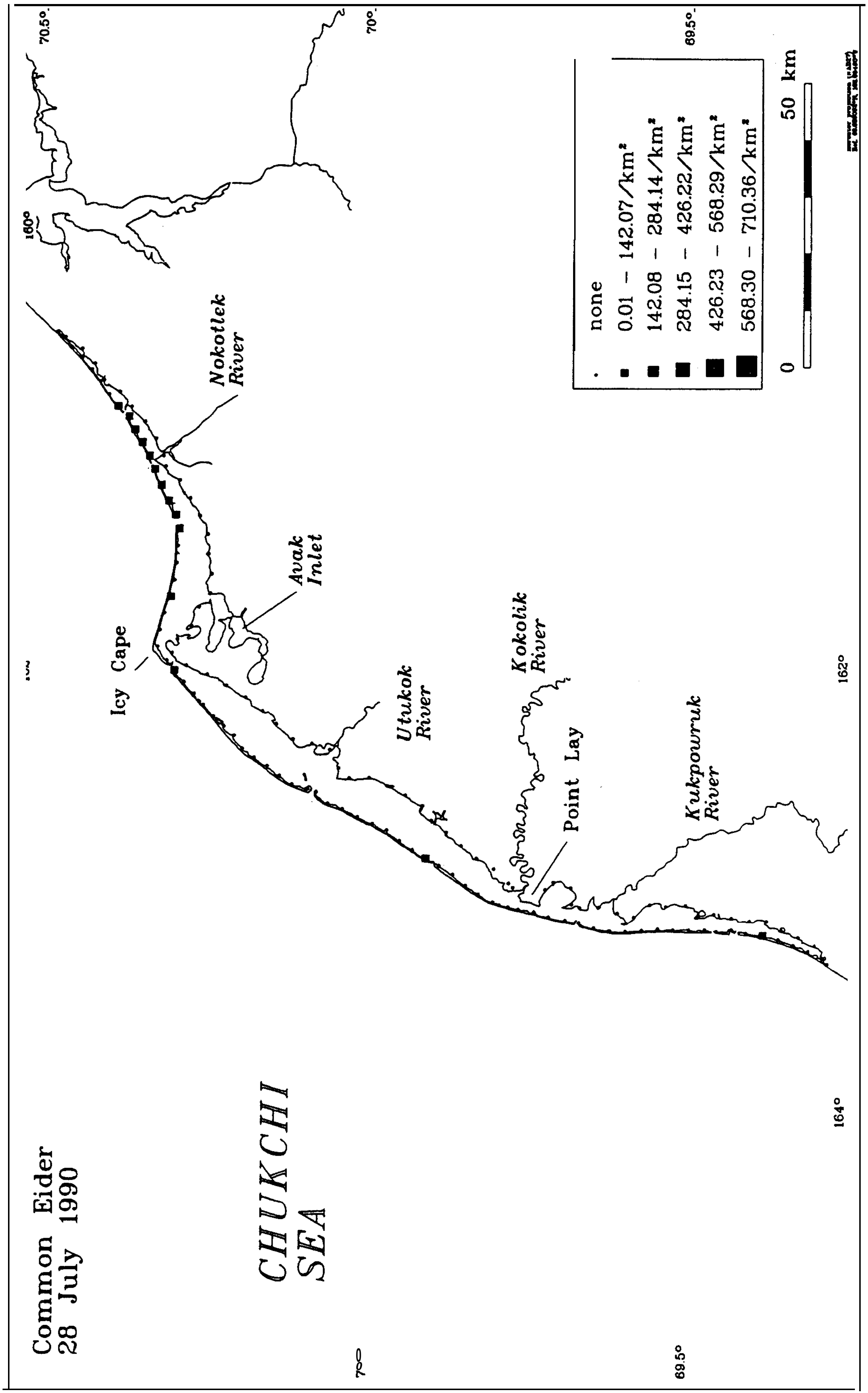

Common Eider
3 September 1989
Icy Cape
CHUKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70°
70.5°
69.5°
none
0.01 – 142.07/km²
142.08 – 284.14/km²
284.15 – 426.22/km²
426.23 – 568.29/km²
568.30 - 710.36/km²
0
50 km


Common Eider
4 September 1989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
Non-standard calculation
(see text)
none
0.01 - 142.07/km²
142.08 - 284.14/km²
284.15 - 426.22/km²
426.23 - 568.29/km²
568.30 - 710.36/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°
69.5°

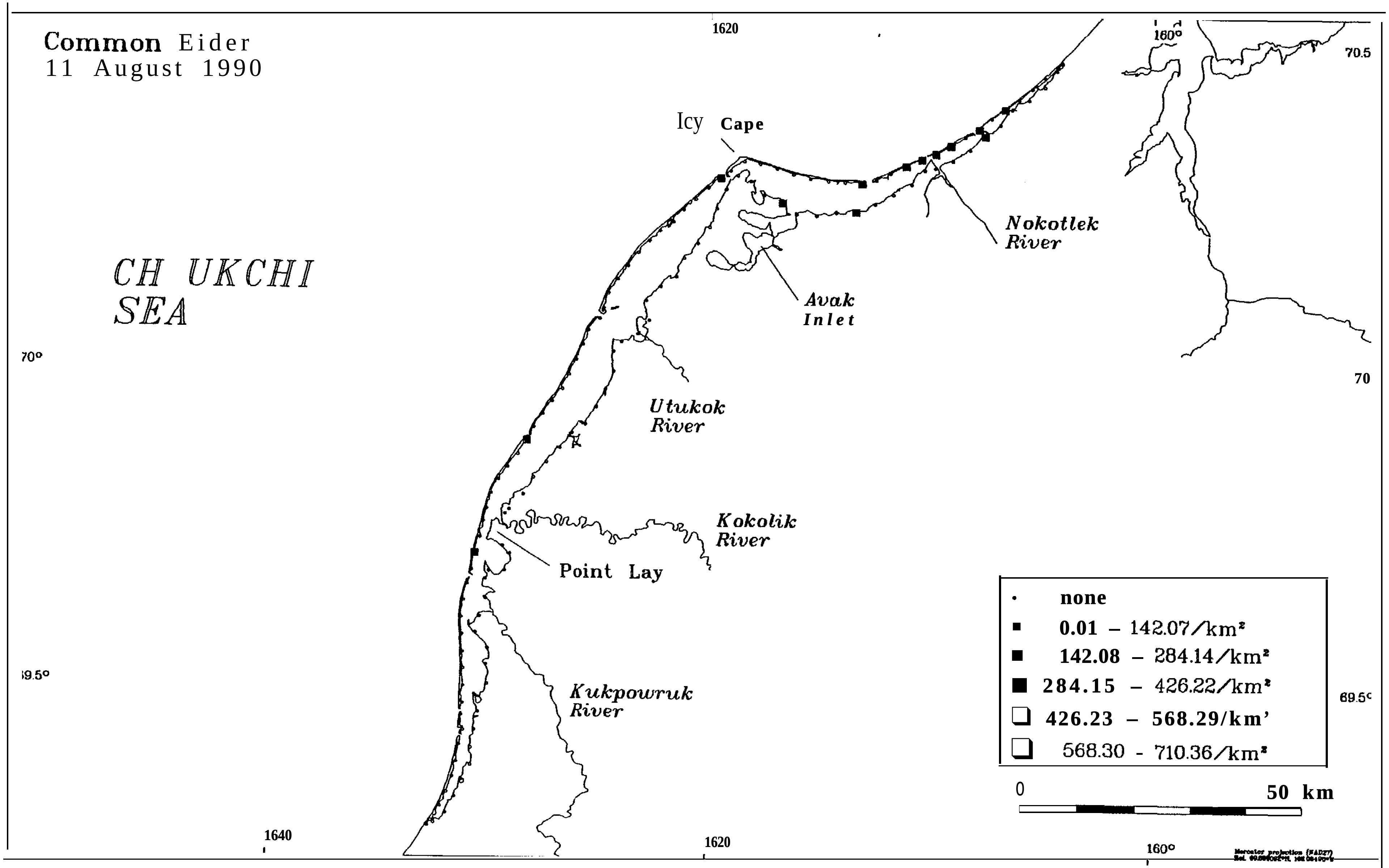

Common Eider
11 September 1989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 142.07/km²
142.08 – 284.14/km²
284.15 – 426.22/km²
426.23 – 568.29/km²
568.30 – 710.36/km²
0
50 km
160°
70°
69.5°

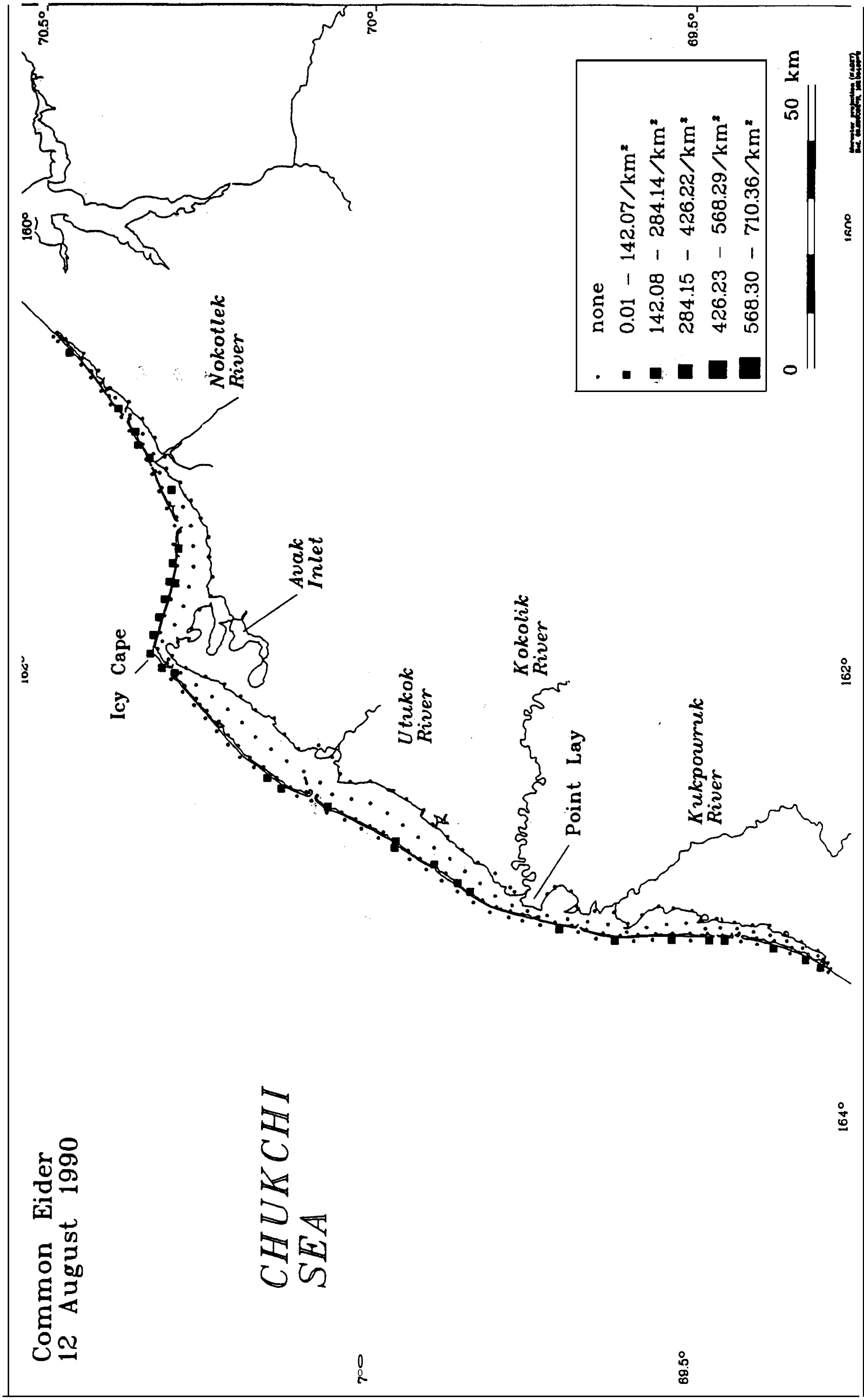


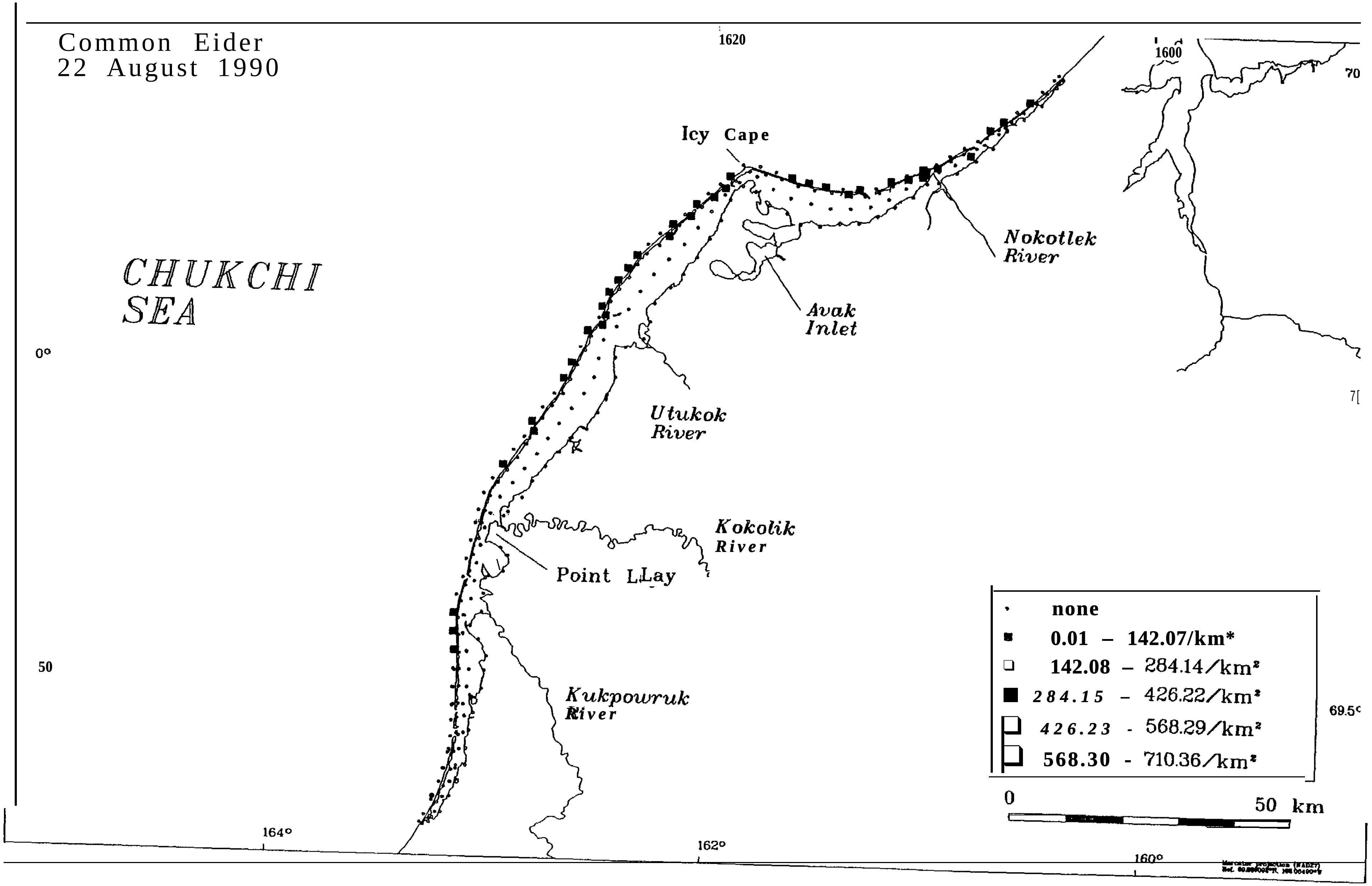
Common Eider
27 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
Non-standard calculation
(see text)
none
0.01 – 142.07/km²
142.08 – 284.14/km²
284.15 – 426.22/km²
426.23 – 568.29/km²
568.30 – 710.36/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

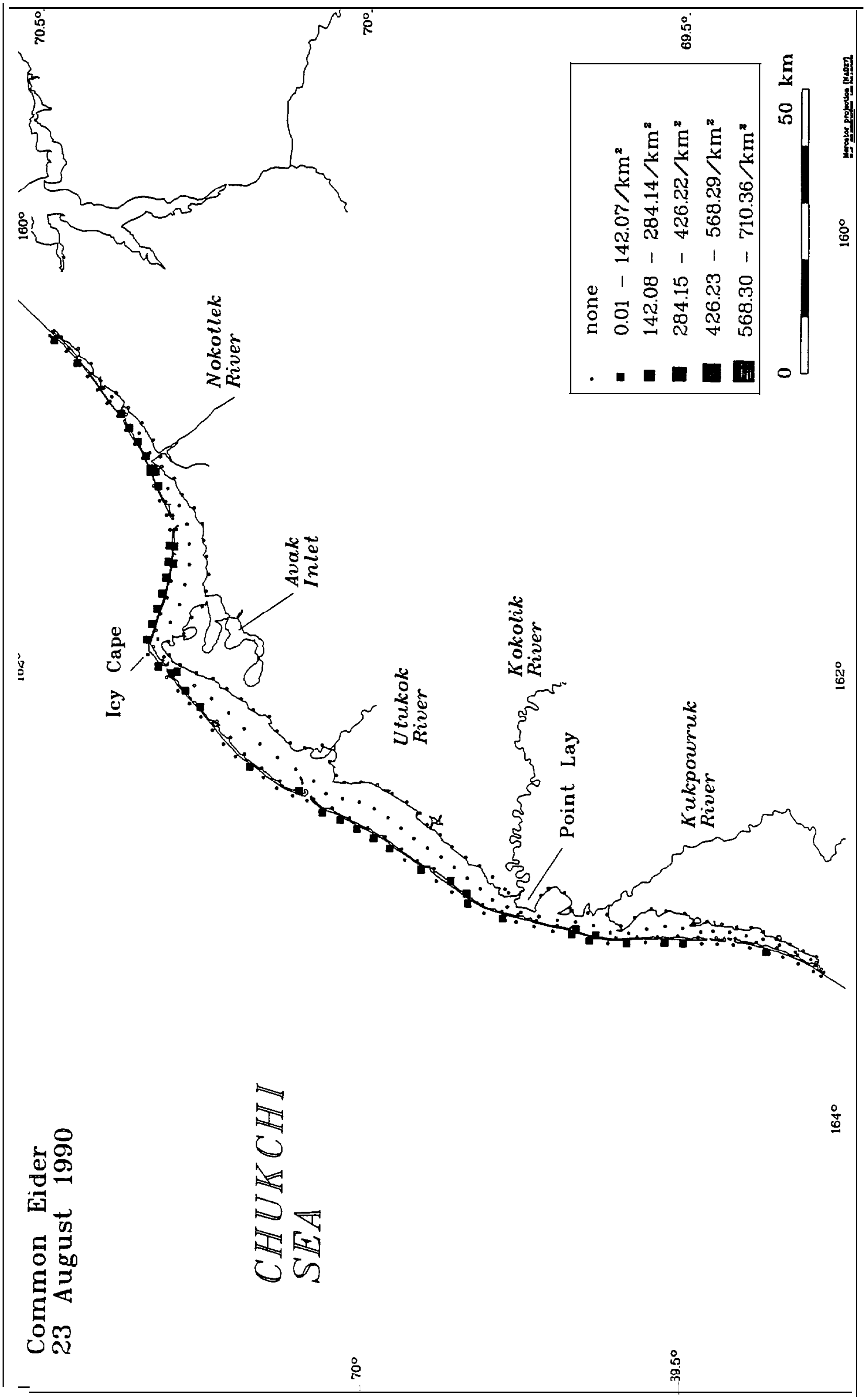


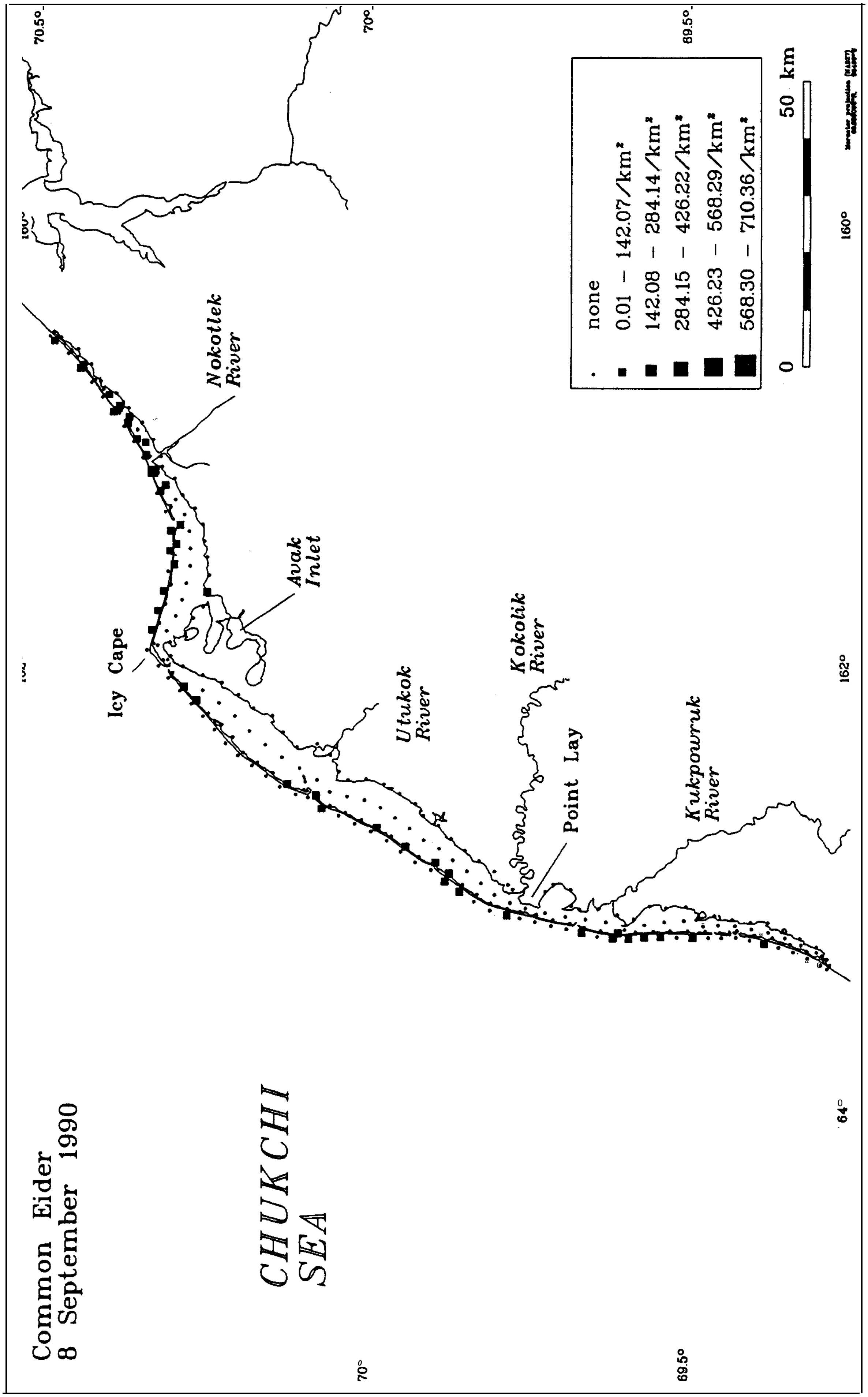
Common Eider
28 July 1990
CHUKCHI
SEA
Icy Cape
Avak
Inlet
Nokotlek
River
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 142.07/km²
142.08 - 284.14/km²
284.15 - 426.22/km²
426.23 - 568.29/km²
568.30 - 710.36/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

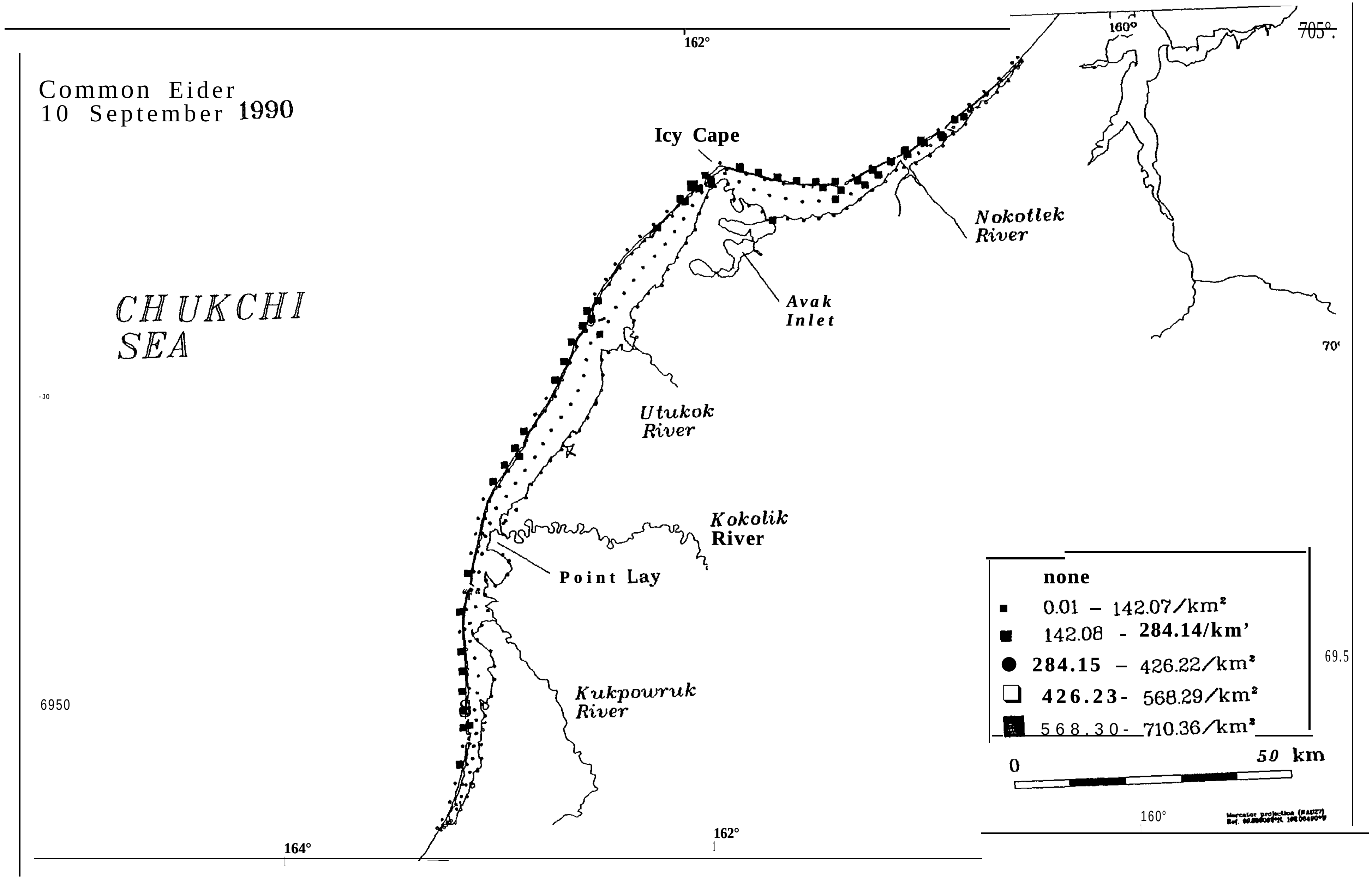

Common Eider
11 August 1990
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
1620
160°
70.5
70°
70
69.5°
69.5°
1640
1620
160°
• none
▪ 0.01 – 142.07/km²
▪ 142.08 – 284.14/km²
■ 284.15 – 426.22/km²
❑ 426.23 – 568.29/km²
❑ 568.30 - 710.36/km²
0
50 km

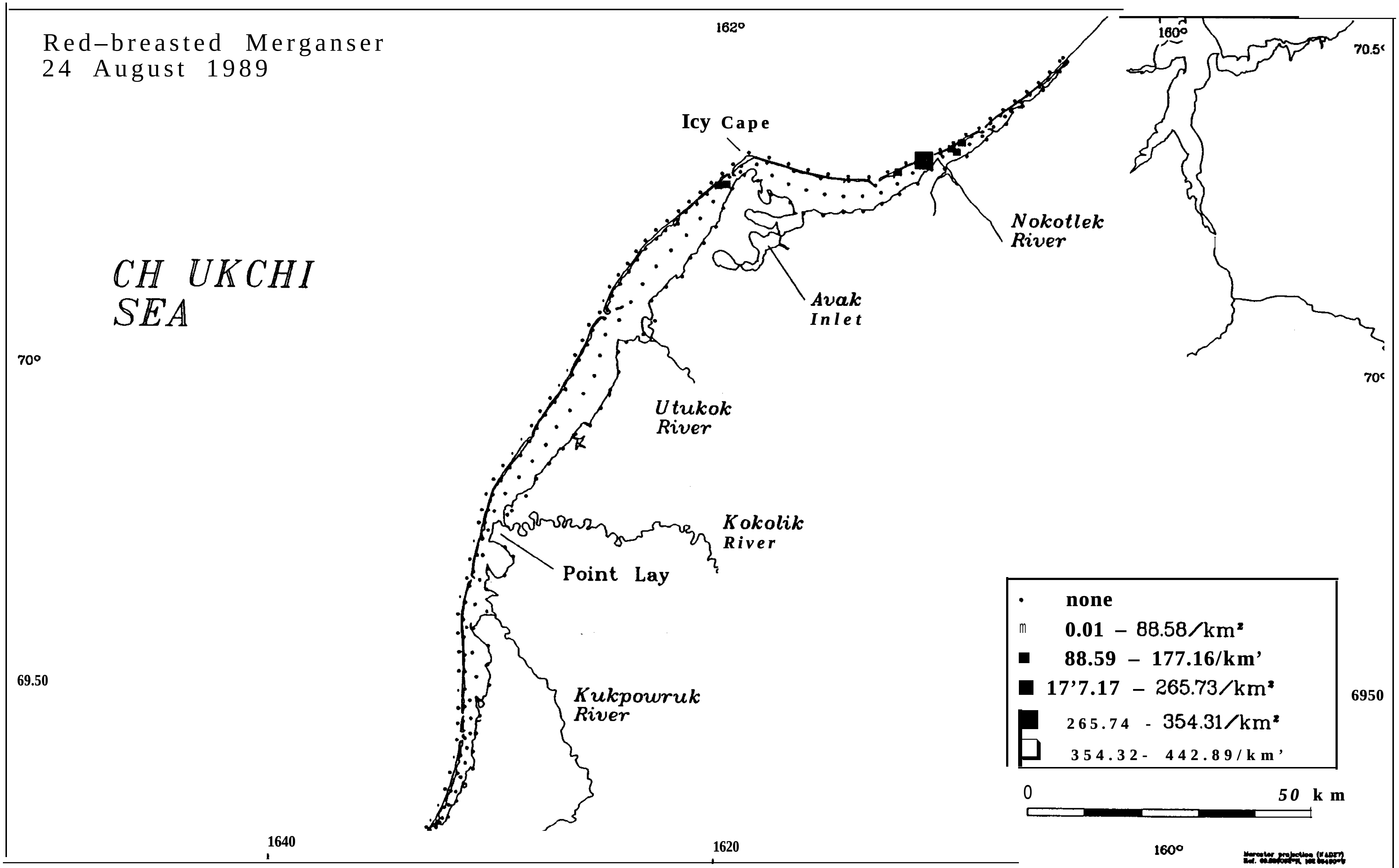

Common Eider
12 August 1990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 142.07/km²
142.08 - 284.14/km²
284.15 - 426.22/km²
426.23 - 568.29/km²
568.30 - 710.36/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

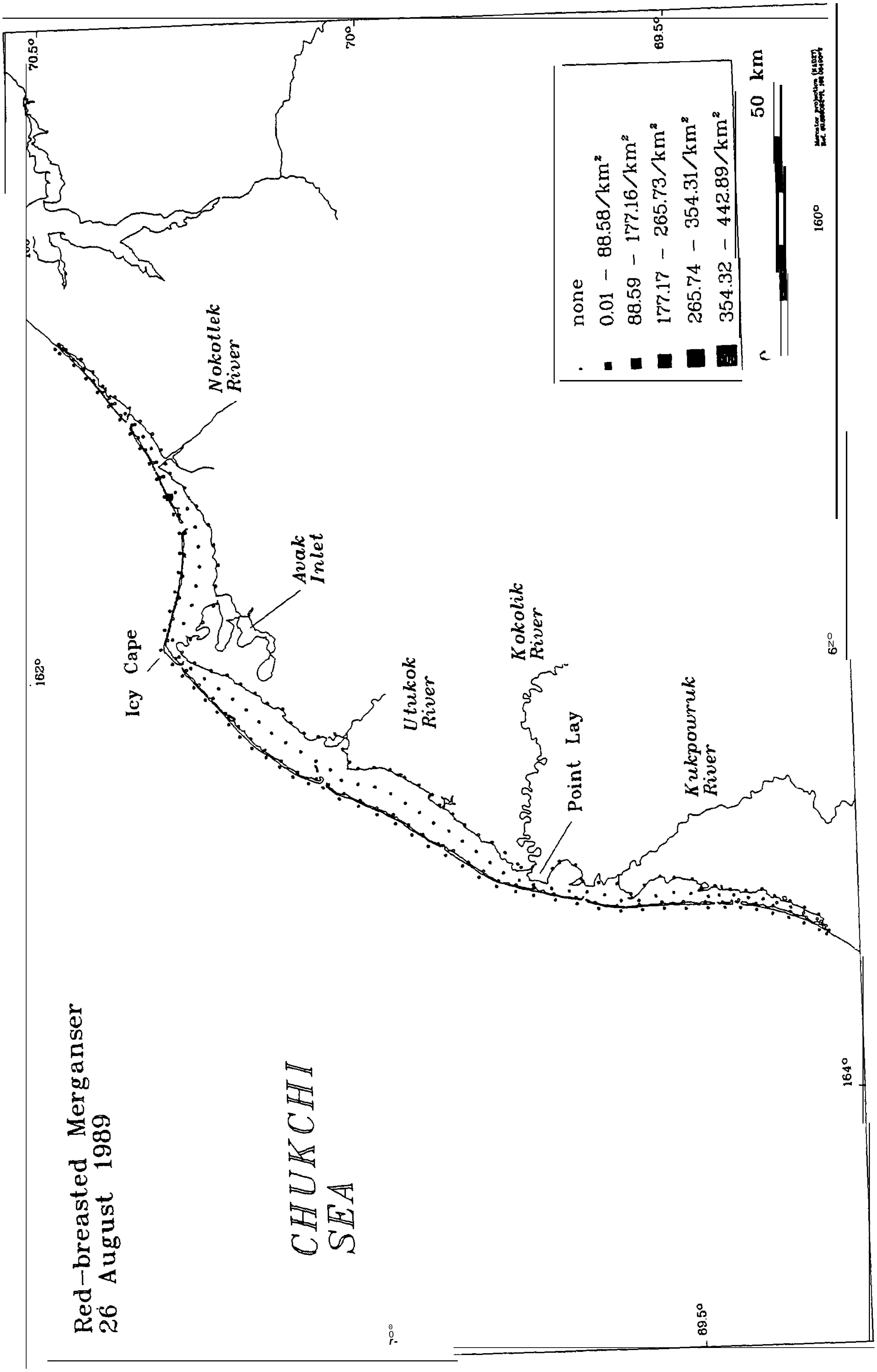

Common Eider
22 August 1990
1620
1600
70
Icy Cape
CHUKCHI
SEA
0°
Nokotlek
River
Avak
Inlet
Utukok
River
7[
Kokolik
River
Point Lay
50
Kukpowruk
River
none
0.01 – 142.07/km*
142.08 – 284.14/km²
284.15 – 426.22/km²
426.23 - 568.29/km²
568.30 - 710.36/km²
69.5°
0
50 km
164°
162°
160°

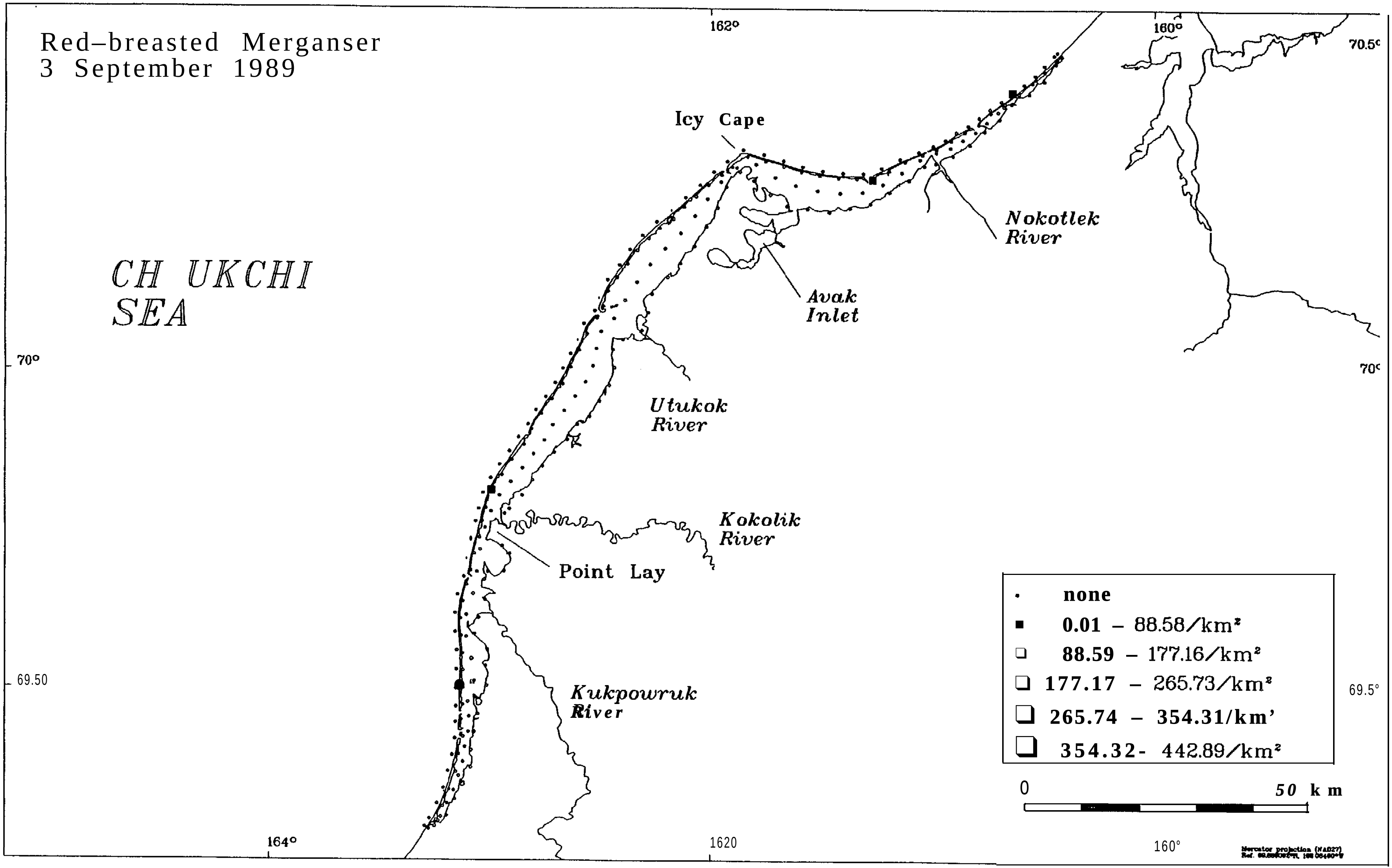

Common Eider
23 August 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 142.07/km²
142.08 – 284.14/km²
284.15 – 426.22/km²
426.23 – 568.29/km²
568.30 – 710.36/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

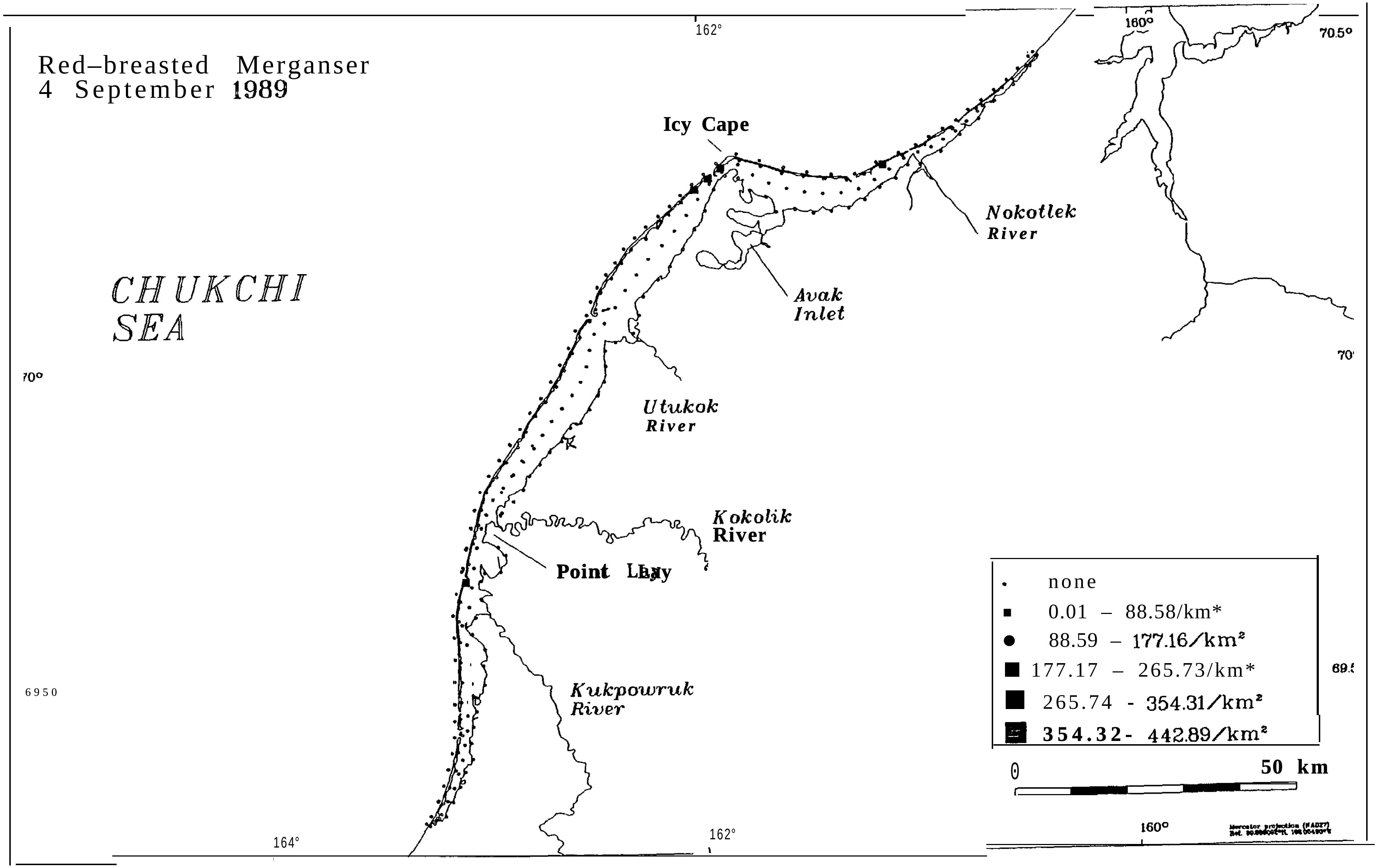

Common Eider
8 September 1990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 142.07/km²
142.08 - 284.14/km²
284.15 - 426.22/km²
426.23 - 568.29/km²
568.30 - 710.36/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

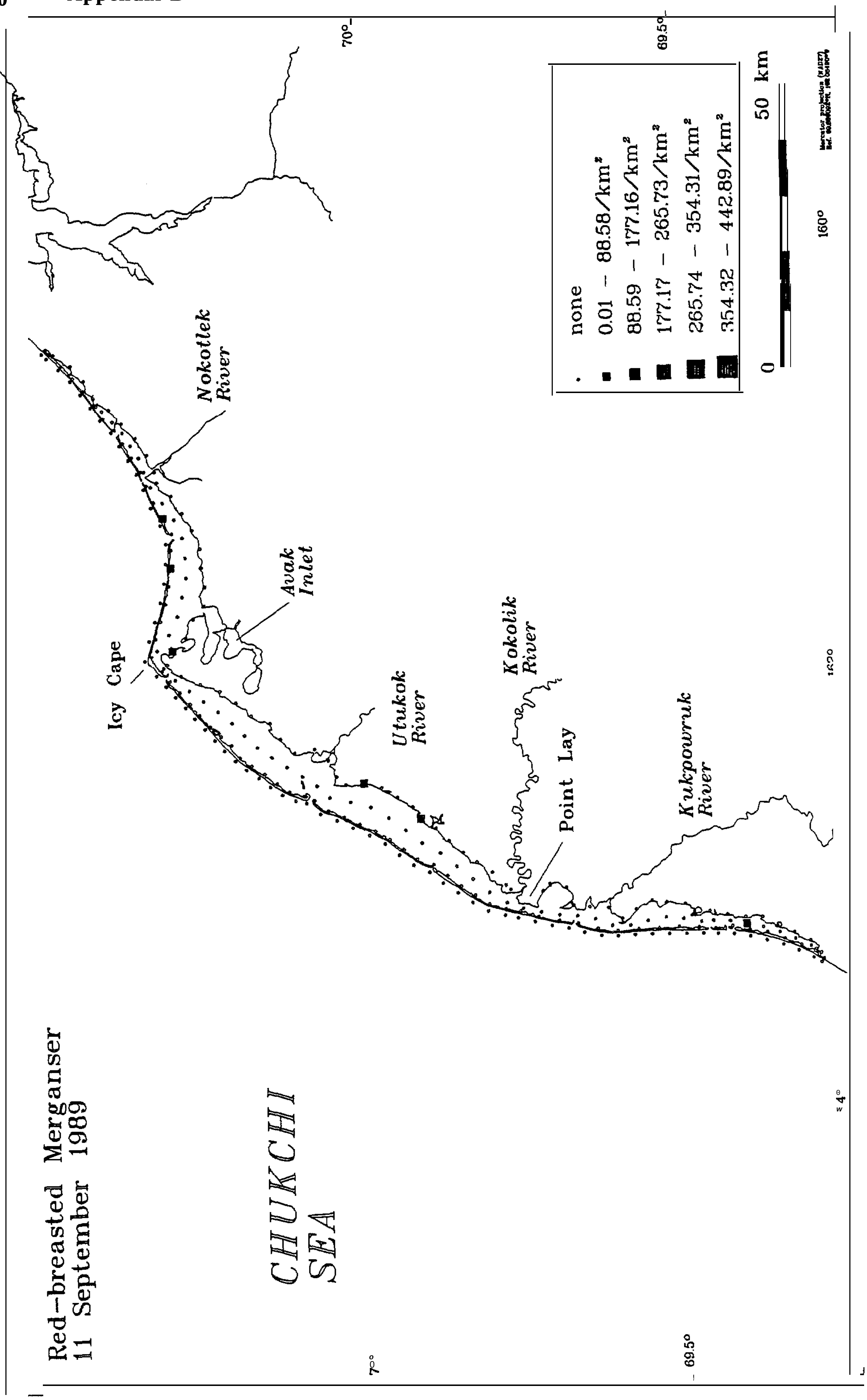

Common Eider
10 September 1990
Icy Cape
CHUKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 142.07/km²
142.08 - 284.14/km'
284.15 – 426.22/km²
426.23- 568.29/km²
568.30- 710.36/km²
0
50 km
162°
160°
164°
162°
160°
70°
69.5
6950
705°.

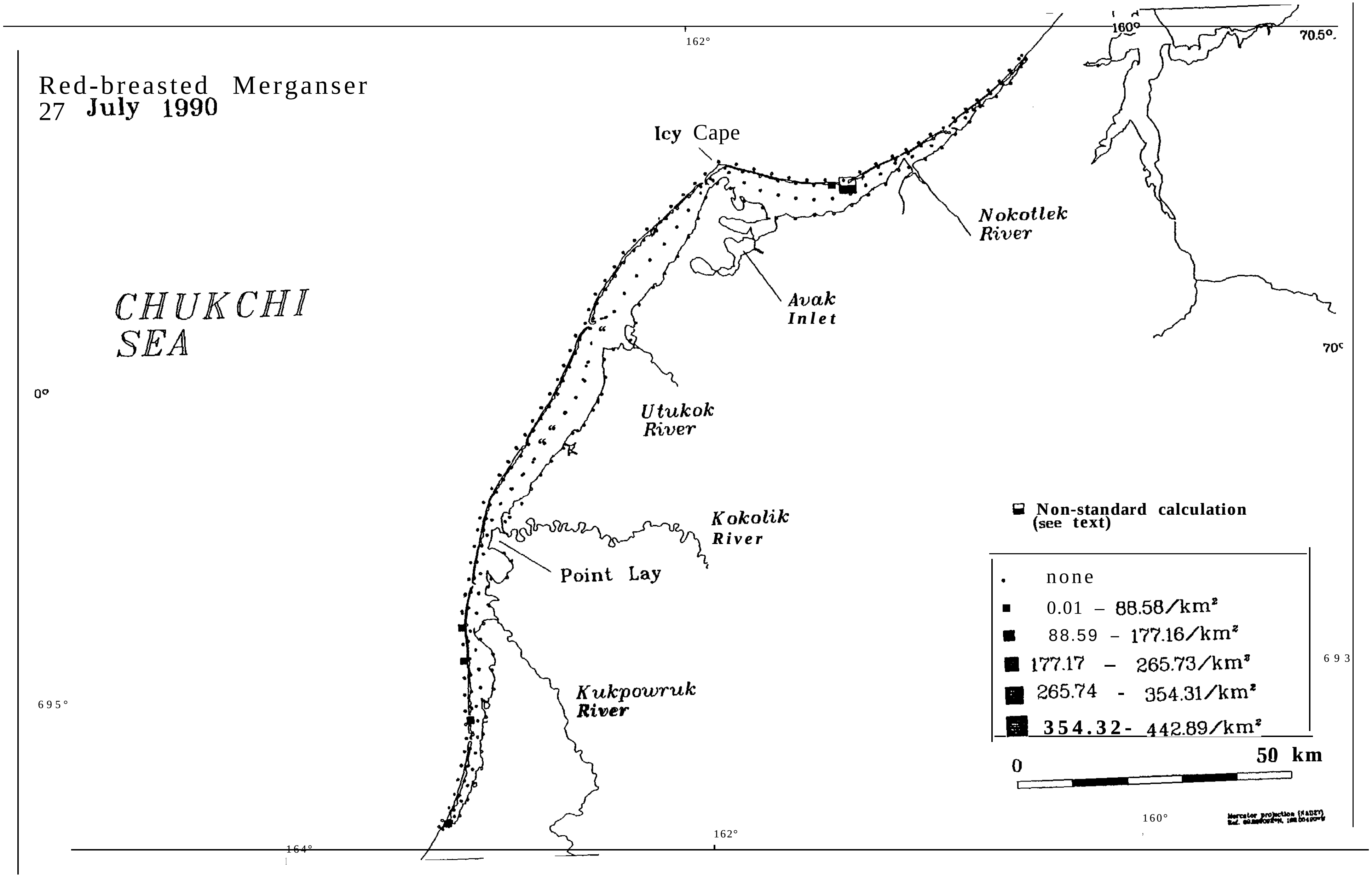

Red–breasted Merganser
24 August 1989
CH UKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
160°
70.5°
70°
70°
69.50
6950
1640
1620
160°
none
0.01 – 88.58/km²
88.59 – 177.16/km'
17'7.17 – 265.73/km²
265.74 - 354.31/km²
354.32- 442.89/km'
0
50 km


Red-breasted Merganser
26 August 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 88.58/km²
88.59 - 177.16/km²
177.17 - 265.73/km²
265.74 - 354.31/km²
354.32 - 442.89/km²
50 km
70.5°
70°
69.5°
162°
160°
164°

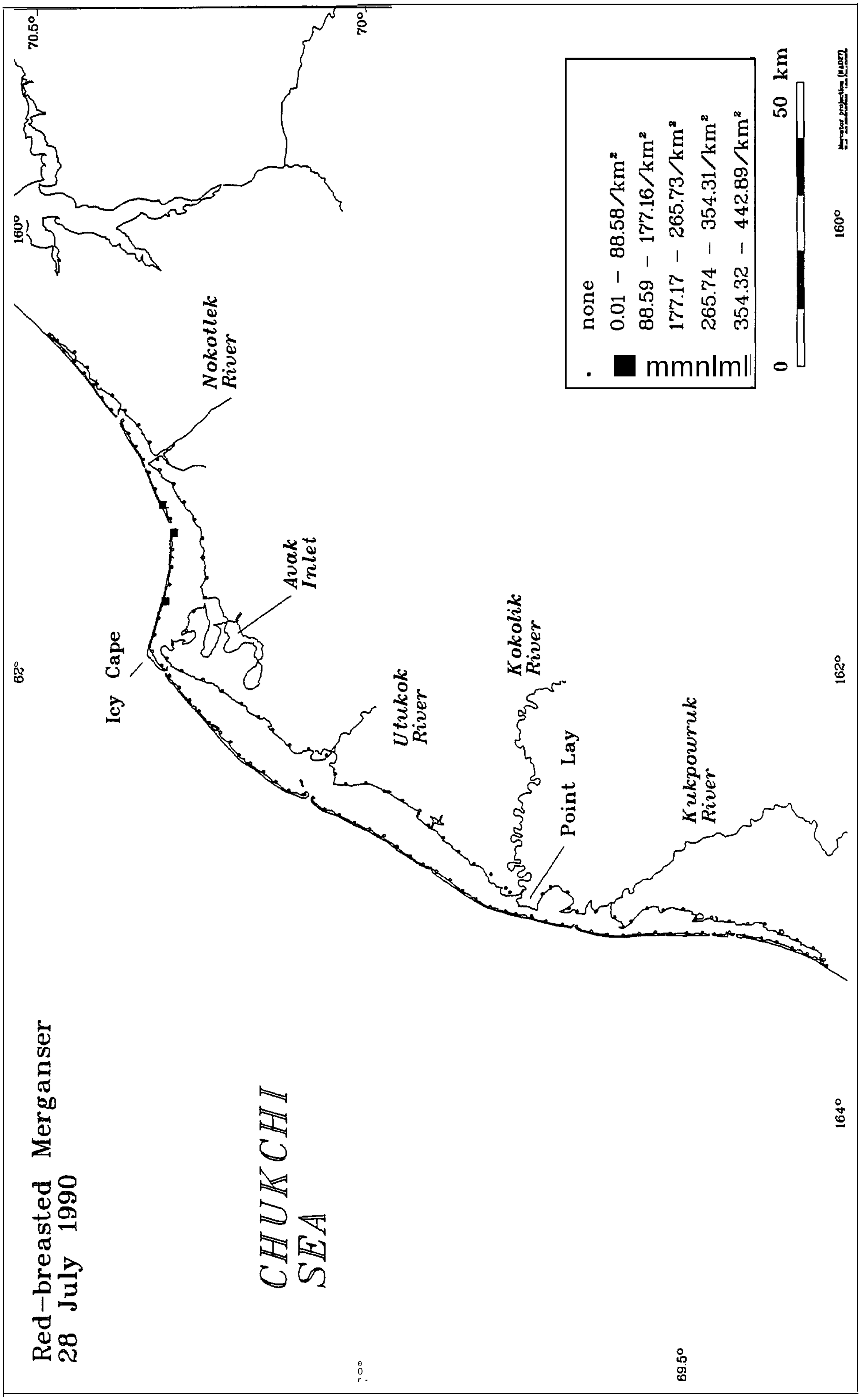

Red–breasted Merganser
3 September 1989
162°
160°
70.5°
Icy Cape
Nokotlek
River
Avak
Inlet
CH UKCHI
SEA
70°
70°
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
69.50
69.5°
164°
1620
160°
none
0.01 – 88.58/km²
88.59 – 177.16/km²
177.17 – 265.73/km²
265.74 – 354.31/km'
354.32- 442.89/km²
0
50 km

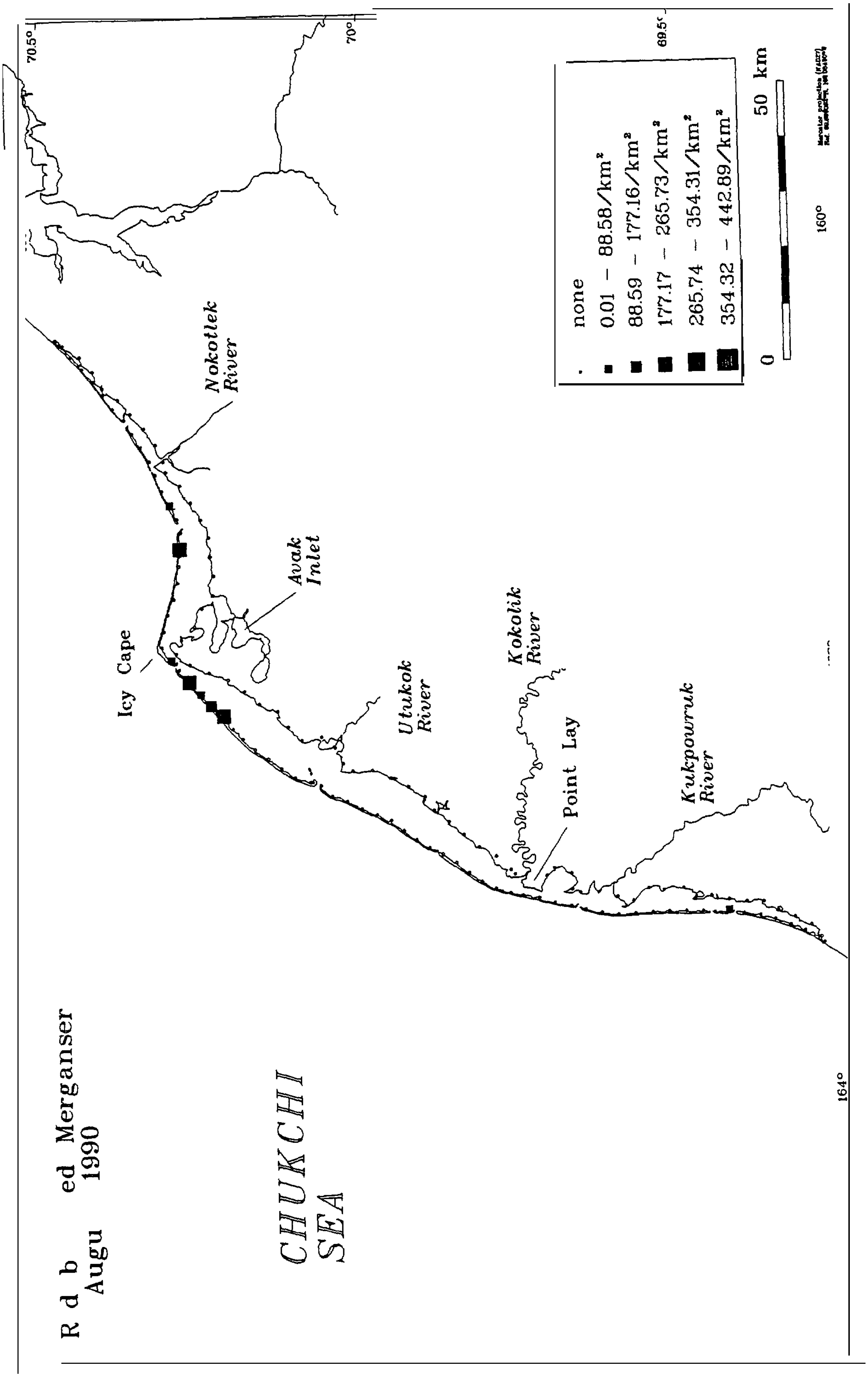

Red–breasted Merganser
4 September 1989
Icy Cape
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 88.58/km*
88.59 – 177.16/km²
177.17 – 265.73/km*
265.74 - 354.31/km²
354.32- 442.89/km²
0
50 km
162°
160°
70.5°
70°
164°
69.5
6950

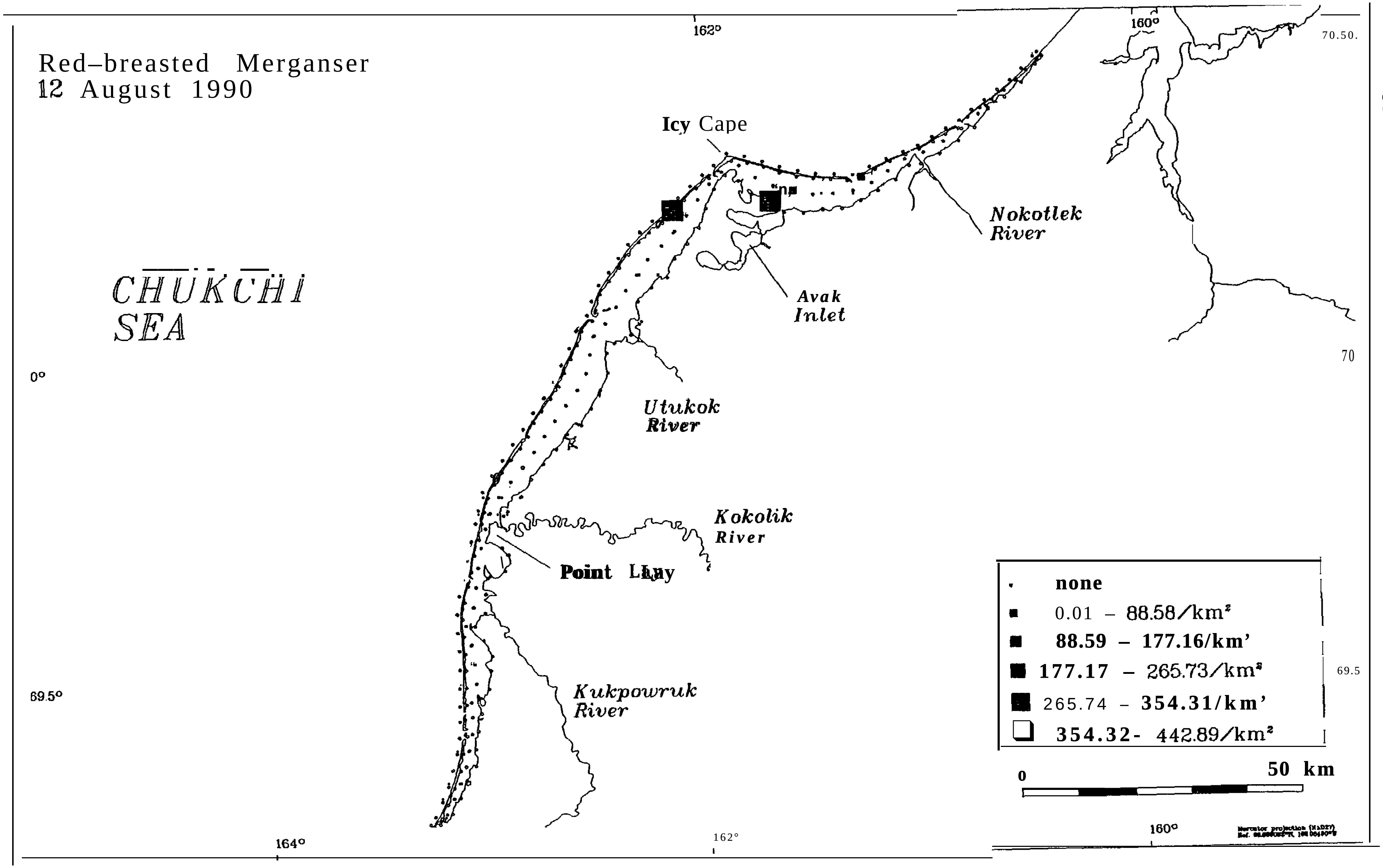

Red-breasted Merganser
11 September 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 88.58/km²
88.59 – 177.16/km²
177.17 – 265.73/km²
265.74 – 354.31/km²
354.32 – 442.89/km²
0
50 km
160°
70°
69.5°

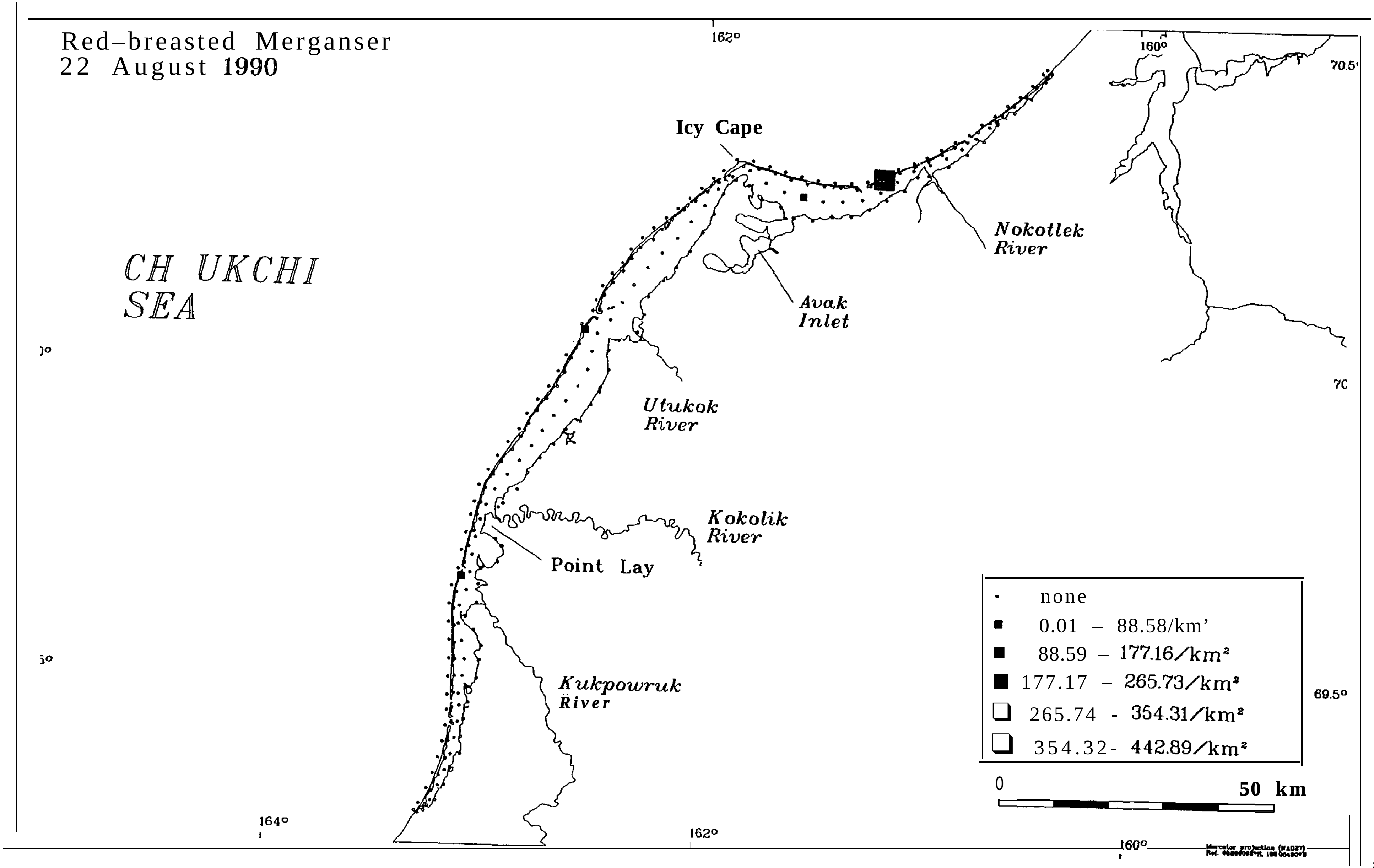


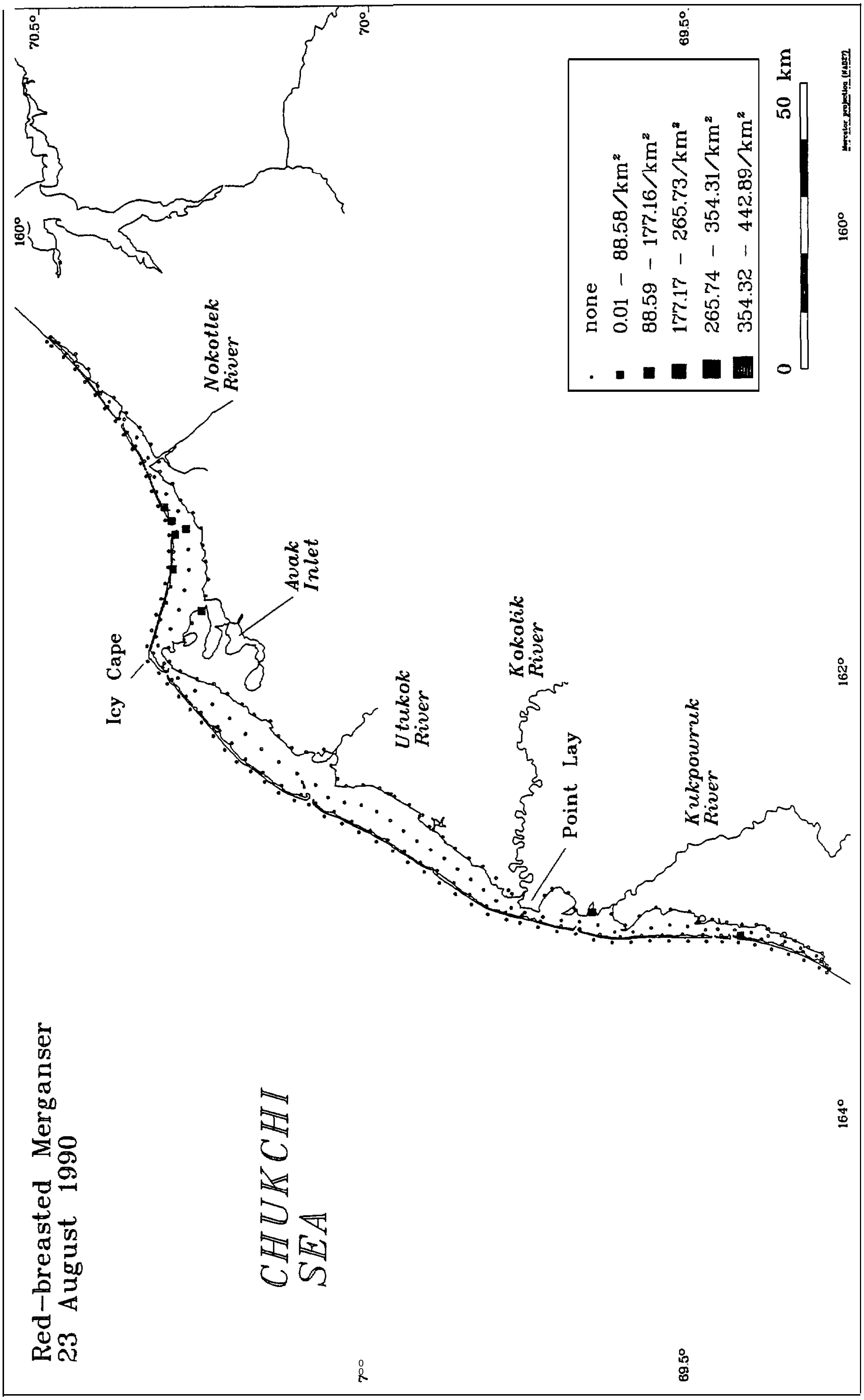
Red-breasted Merganser
27 July 1990
Icy Cape
Nokotlek River
Avak Inlet
CHUKCHI SEA
Utukok River
Kokolik River
Point Lay
Kukpowruk River
Non-standard calculation (see text)
none
0.01 – 88.58/km²
88.59 – 177.16/km²
177.17 – 265.73/km²
265.74 - 354.31/km²
354.32- 442.89/km²
0
50 km
162°
160°
164°
70.5°
70°

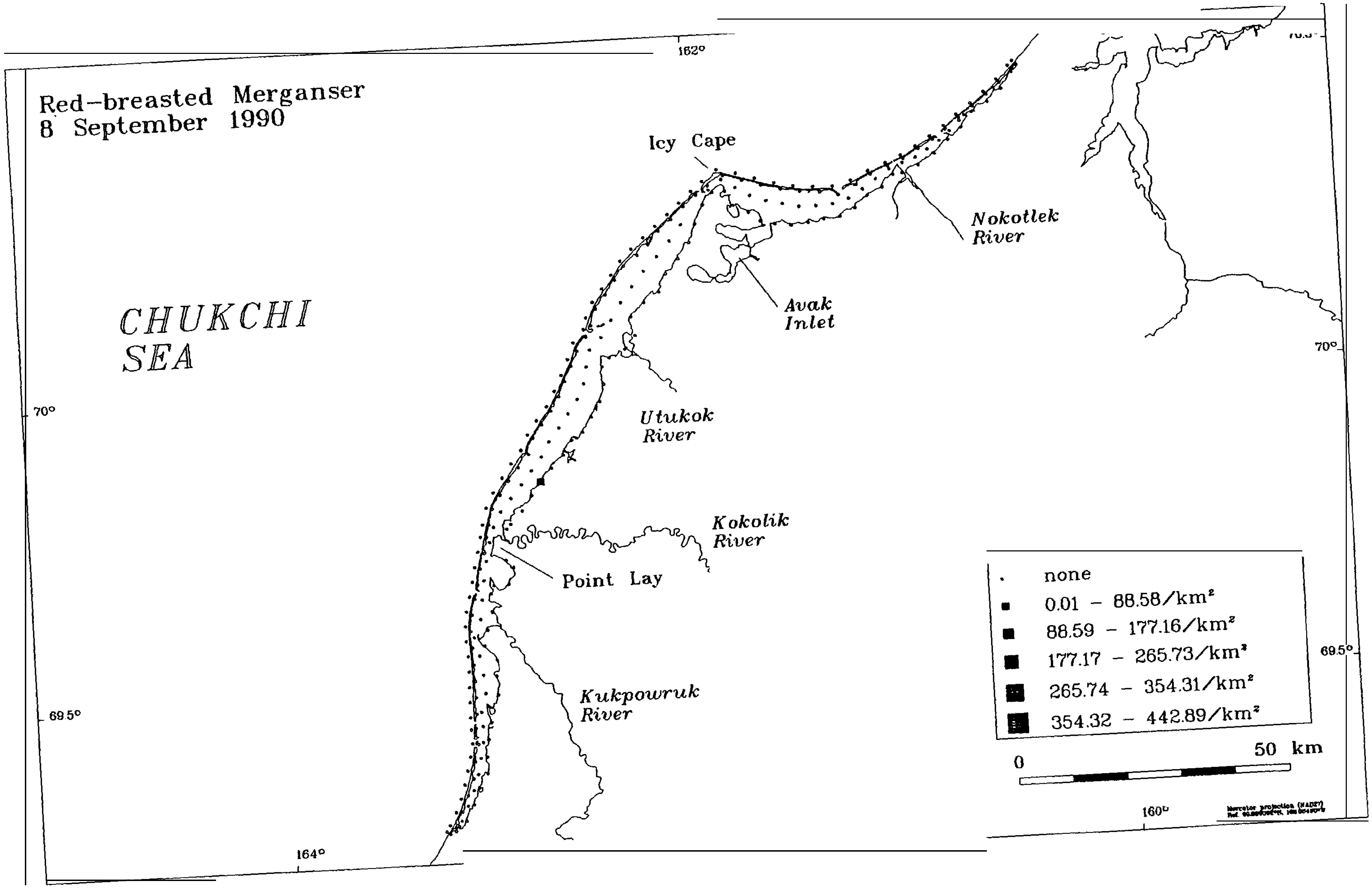

Red-breasted Merganser
28 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 88.58/km²
88.59 - 177.16/km²
177.17 - 265.73/km²
265.74 - 354.31/km²
354.32 - 442.89/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

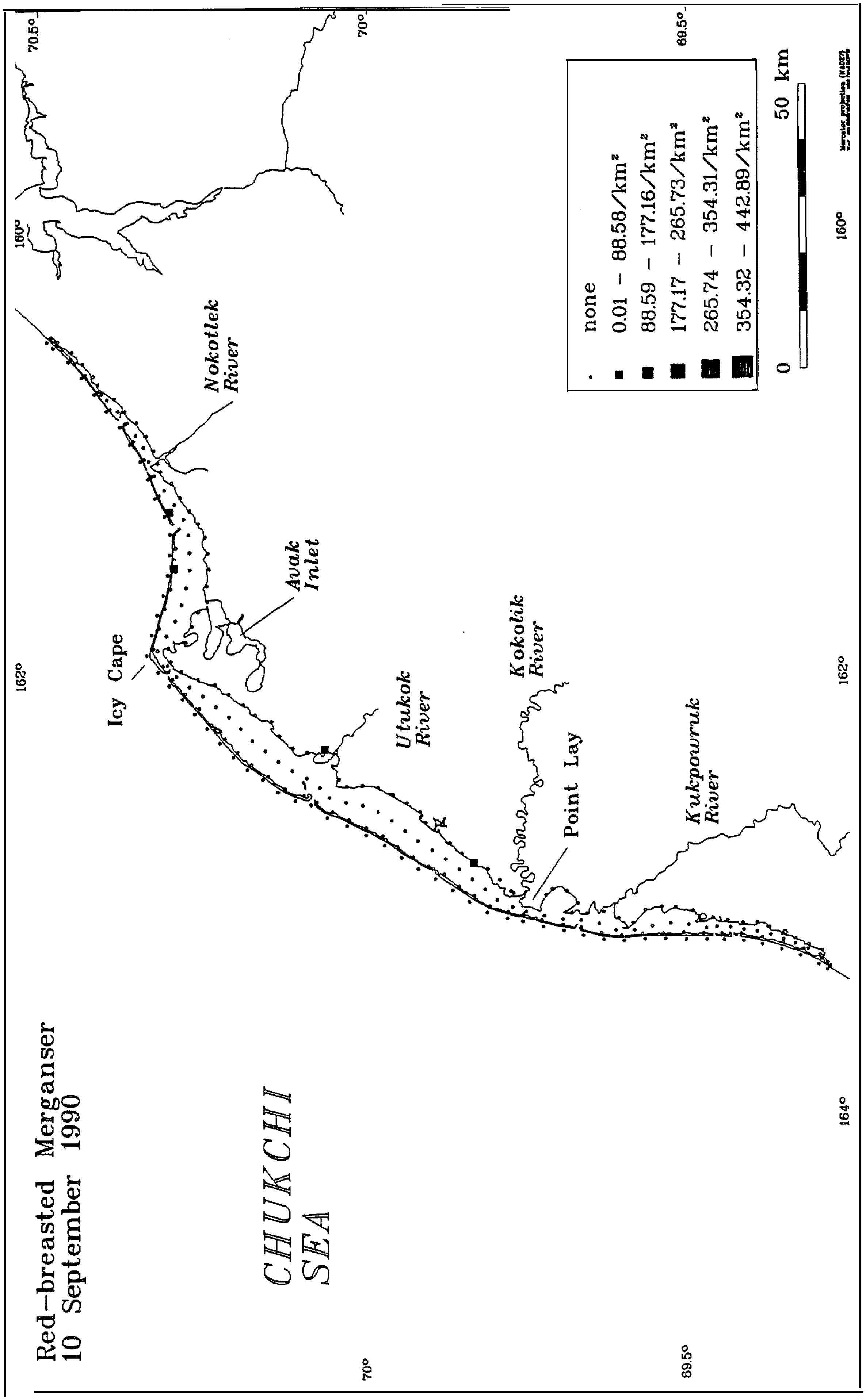

R d b ed Merganser
Augu 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
70.5°
70°
69.5°
164°
160°
none
0.01 – 88.58/km²
88.59 – 177.16/km²
177.17 – 265.73/km²
265.74 – 354.31/km²
354.32 – 442.89/km²
0
50 km

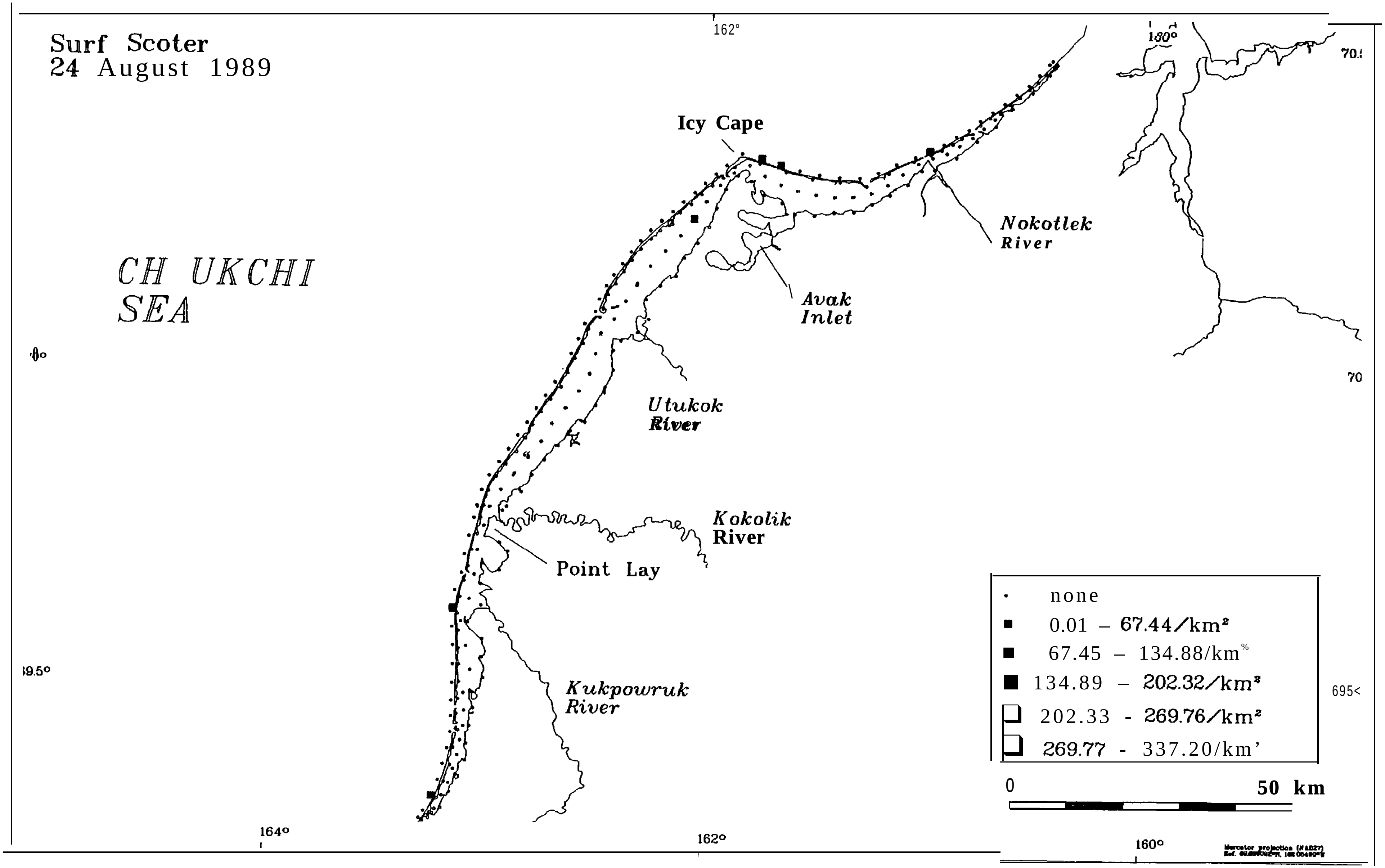

Red–breasted Merganser
12 August 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70.50.
70
69.5
0°
69.5°
none
0.01 – 88.58/km²
88.59 – 177.16/km²
177.17 – 265.73/km²
265.74 – 354.31/km²
354.32 - 442.89/km²
0
50 km

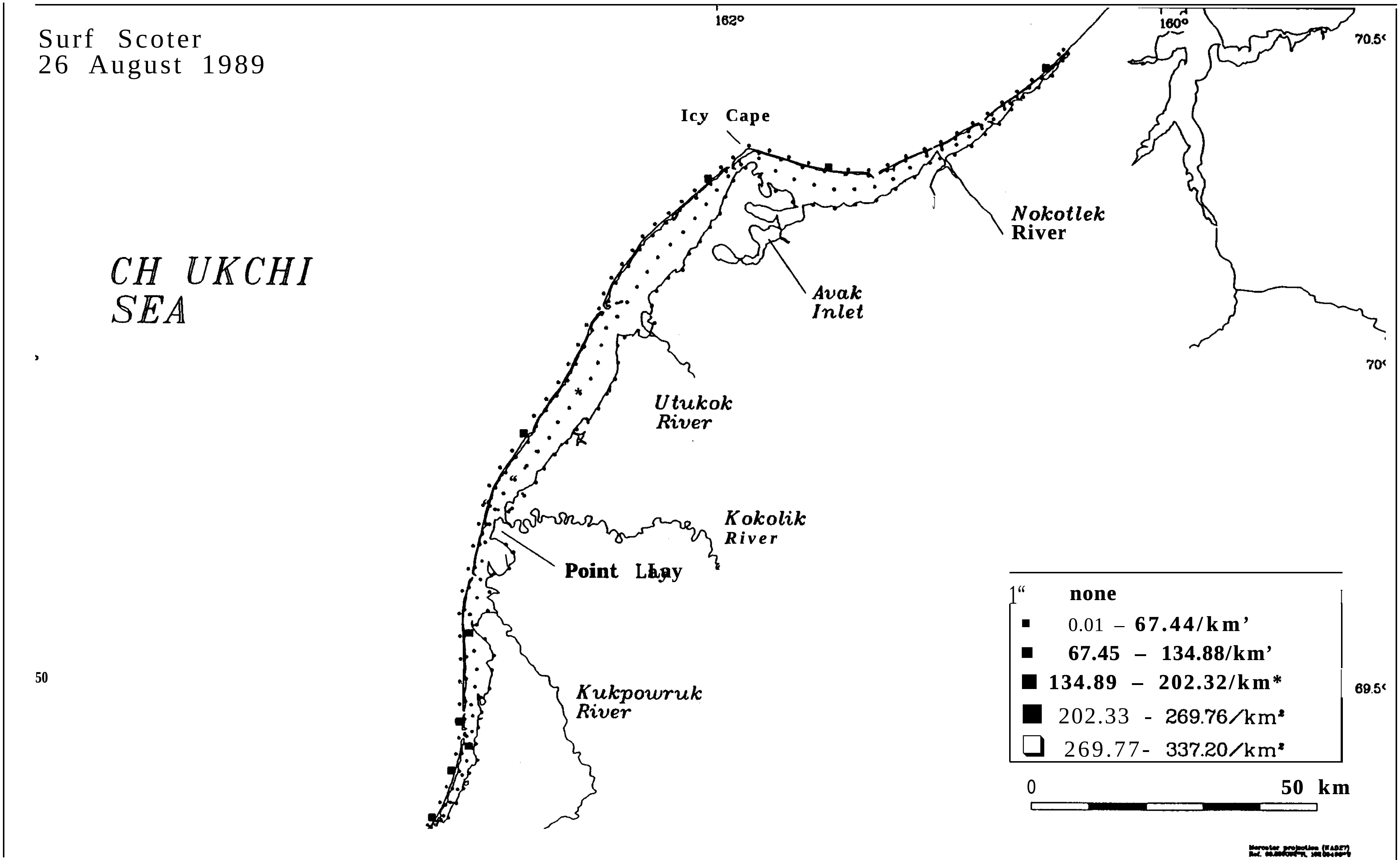

Red–breasted Merganser
22 August 1990
162°
160°
70.5°
Icy Cape
CH UKCHI
SEA
Nokotlek
River
Avak
Inlet
Utukok
River
70
Kokolik
River
Point Lay
Kukpowruk
River
69.5°
164°
162°
160°
• none
0.01 – 88.58/km’
88.59 – 177.16/km²
177.17 – 265.73/km²
265.74 - 354.31/km²
354.32- 442.89/km²
0
50 km

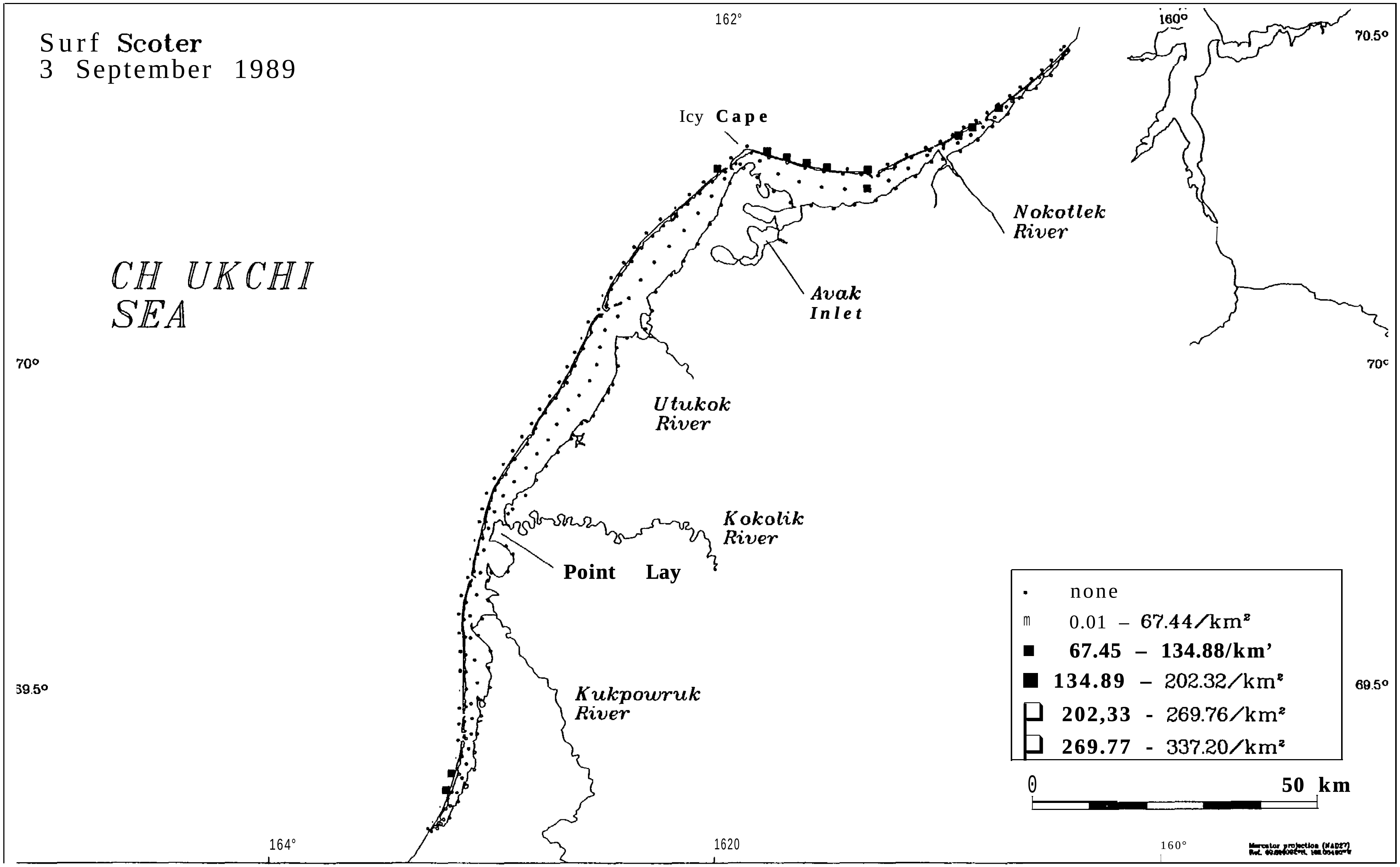

Red-breasted Merganser
23 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 88.58/km²
88.59 - 177.16/km²
177.17 - 265.73/km²
265.74 - 354.31/km²
354.32 - 442.89/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°


Red-breasted Merganser
8 September 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
164°
160°
70°
69.5°
none
0.01 - 88.58/km²
88.59 - 177.16/km²
177.17 - 265.73/km²
265.74 - 354.31/km²
354.32 - 442.89/km²
0
50 km

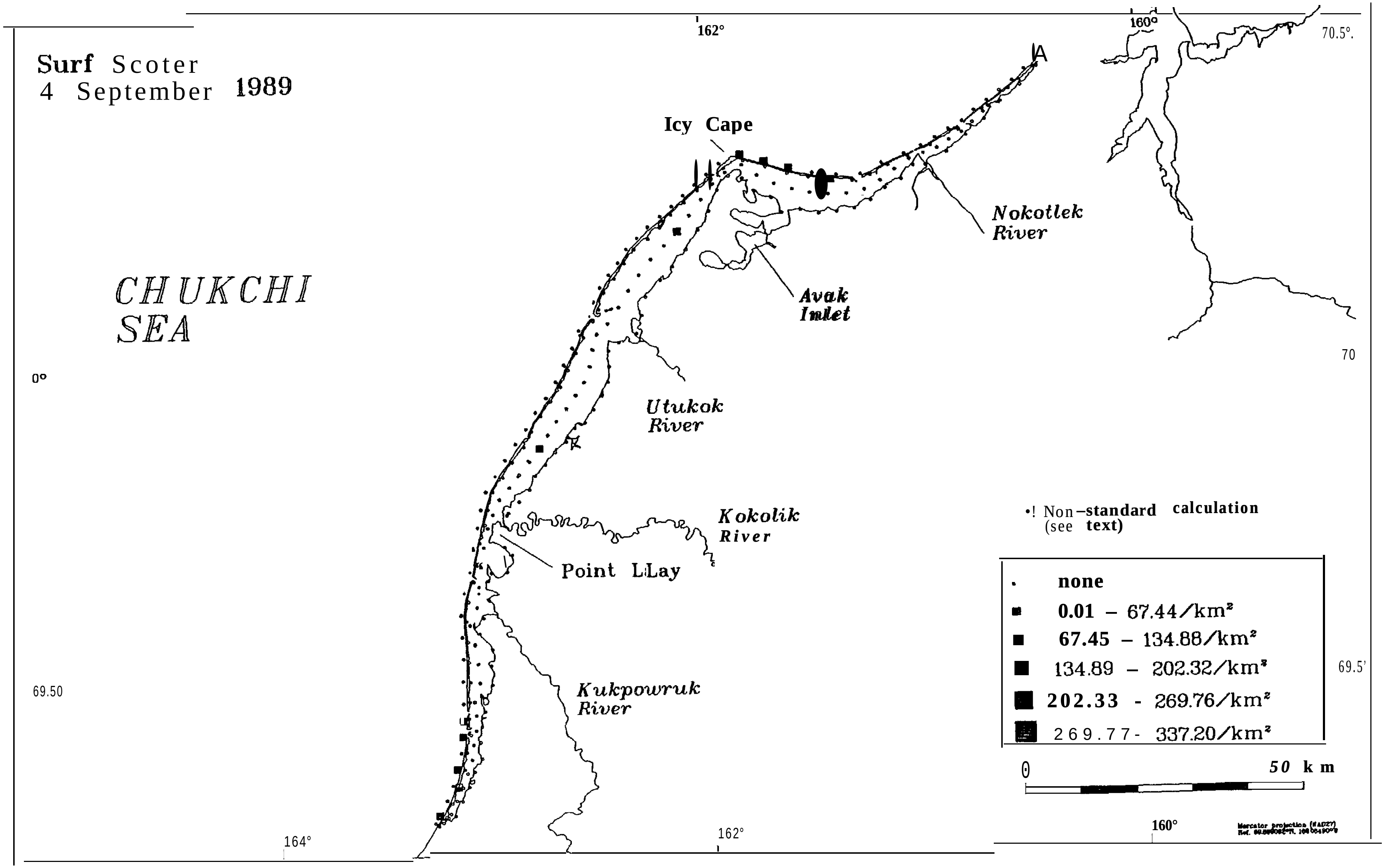

Red–breasted Merganser
10 September 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 88.58/km²
88.59 – 177.16/km²
177.17 – 265.73/km²
265.74 – 354.31/km²
354.32 – 442.89/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

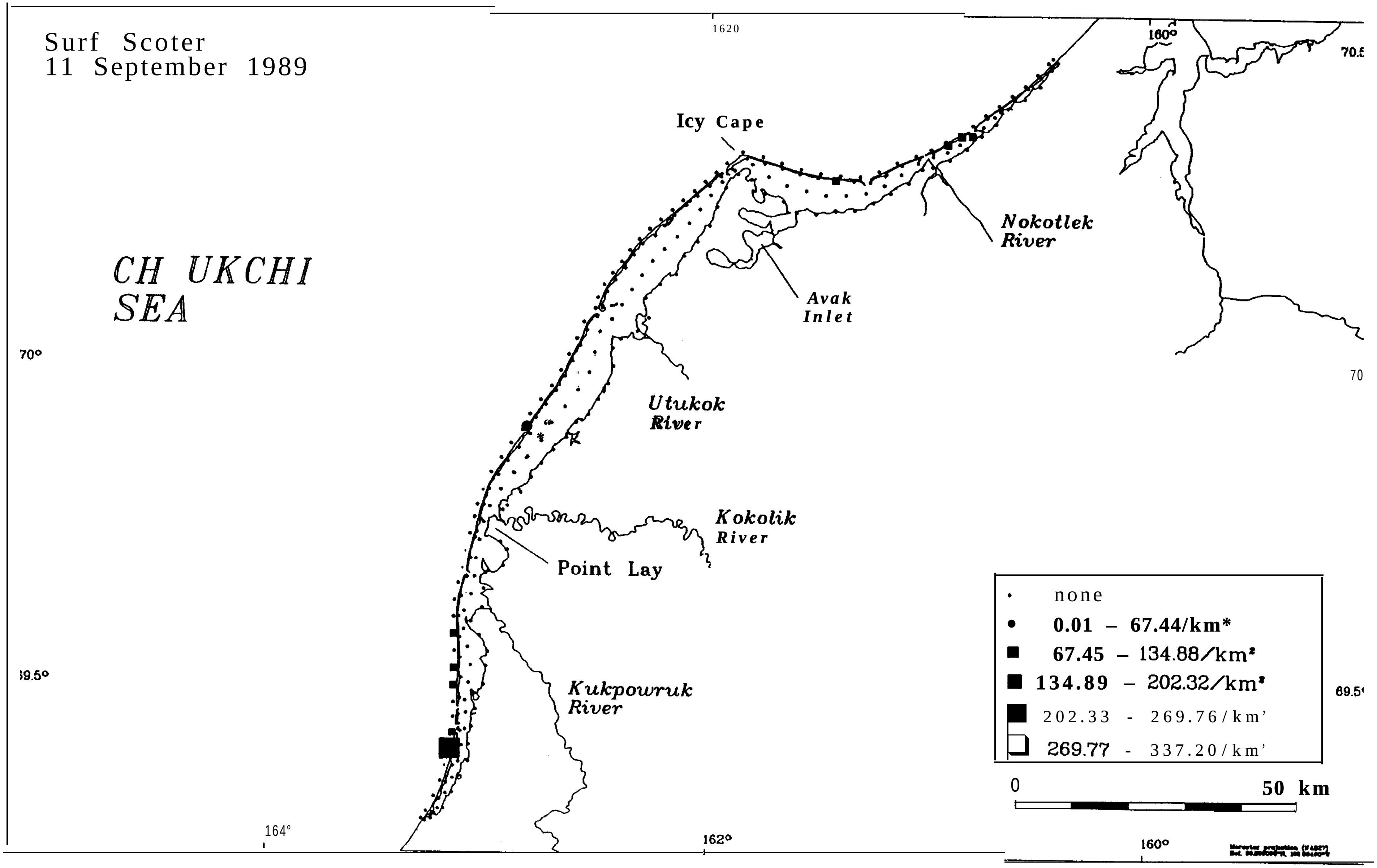

Surf Scoter
24 August 1989
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70
69.5°
none
0.01 – 67.44/km²
67.45 – 134.88/km²
134.89 – 202.32/km²
202.33 - 269.76/km²
269.77 - 337.20/km²
0
50 km
Mercator projection (NAD27)

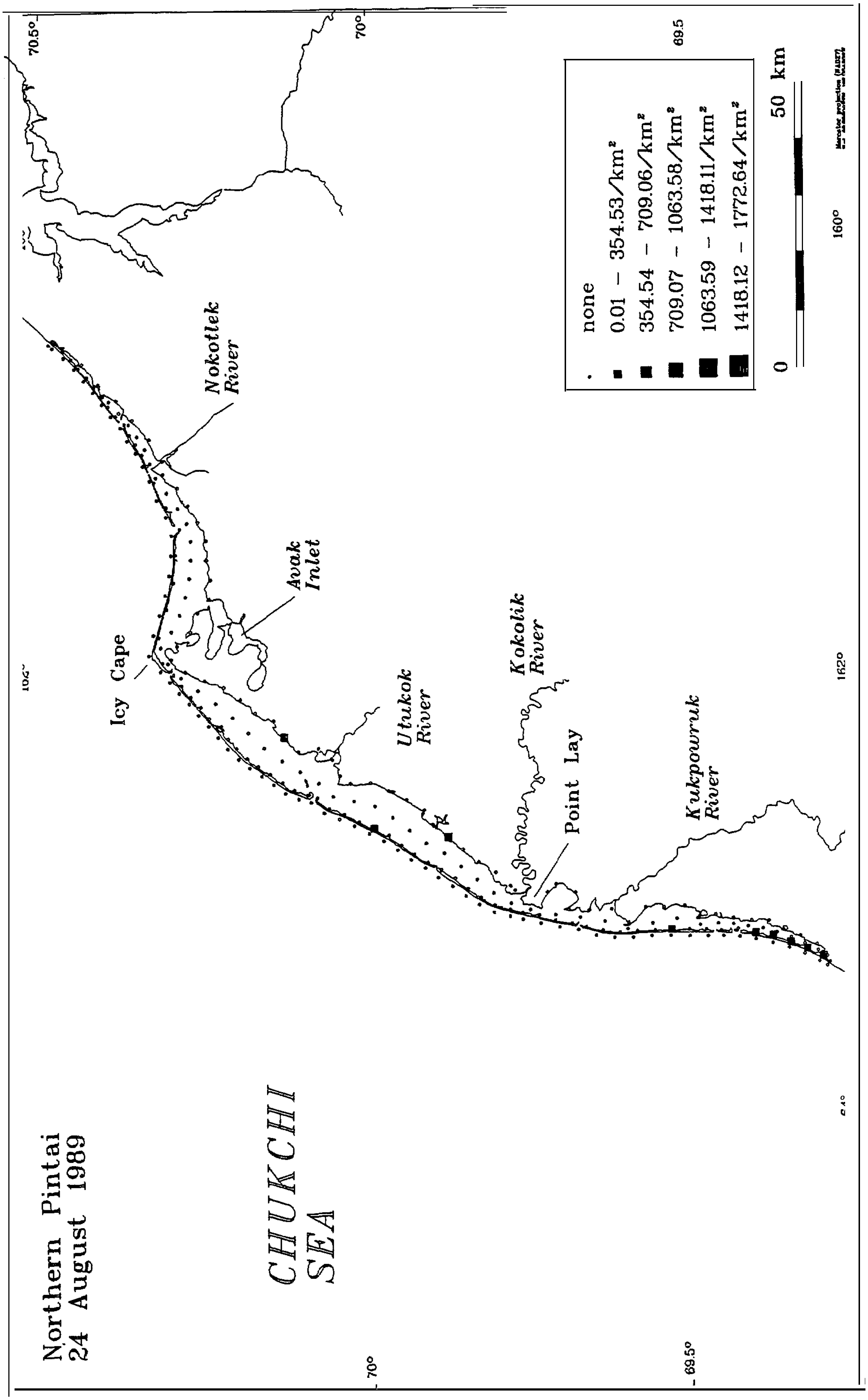

Surf Scoter
26 August 1989
162°
160°
70.5°
70°
69.5°
Icy Cape
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 67.44/km²
67.45 – 134.88/km²
134.89 – 202.32/km²
202.33 - 269.76/km²
269.77- 337.20/km²
0
50 km

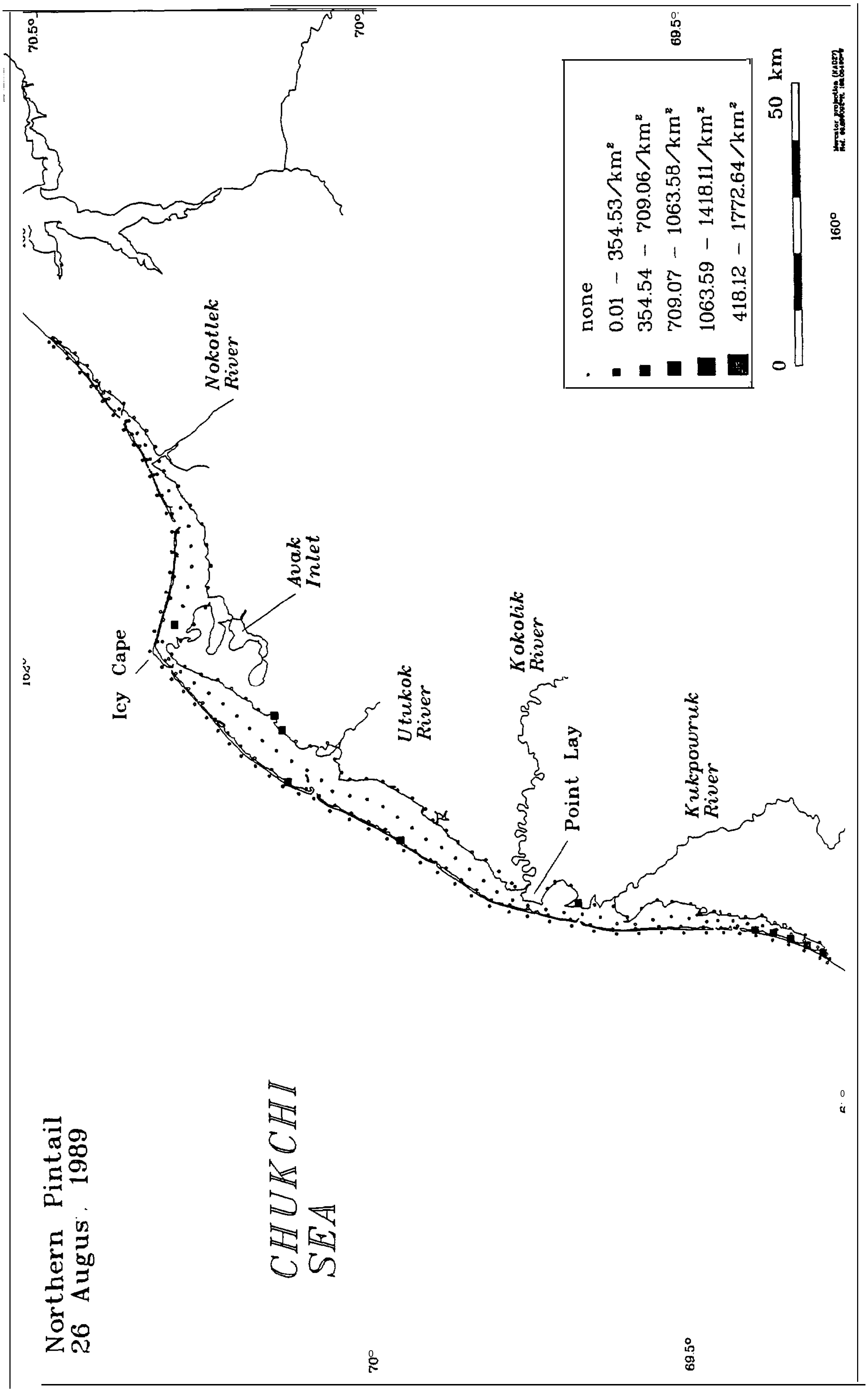


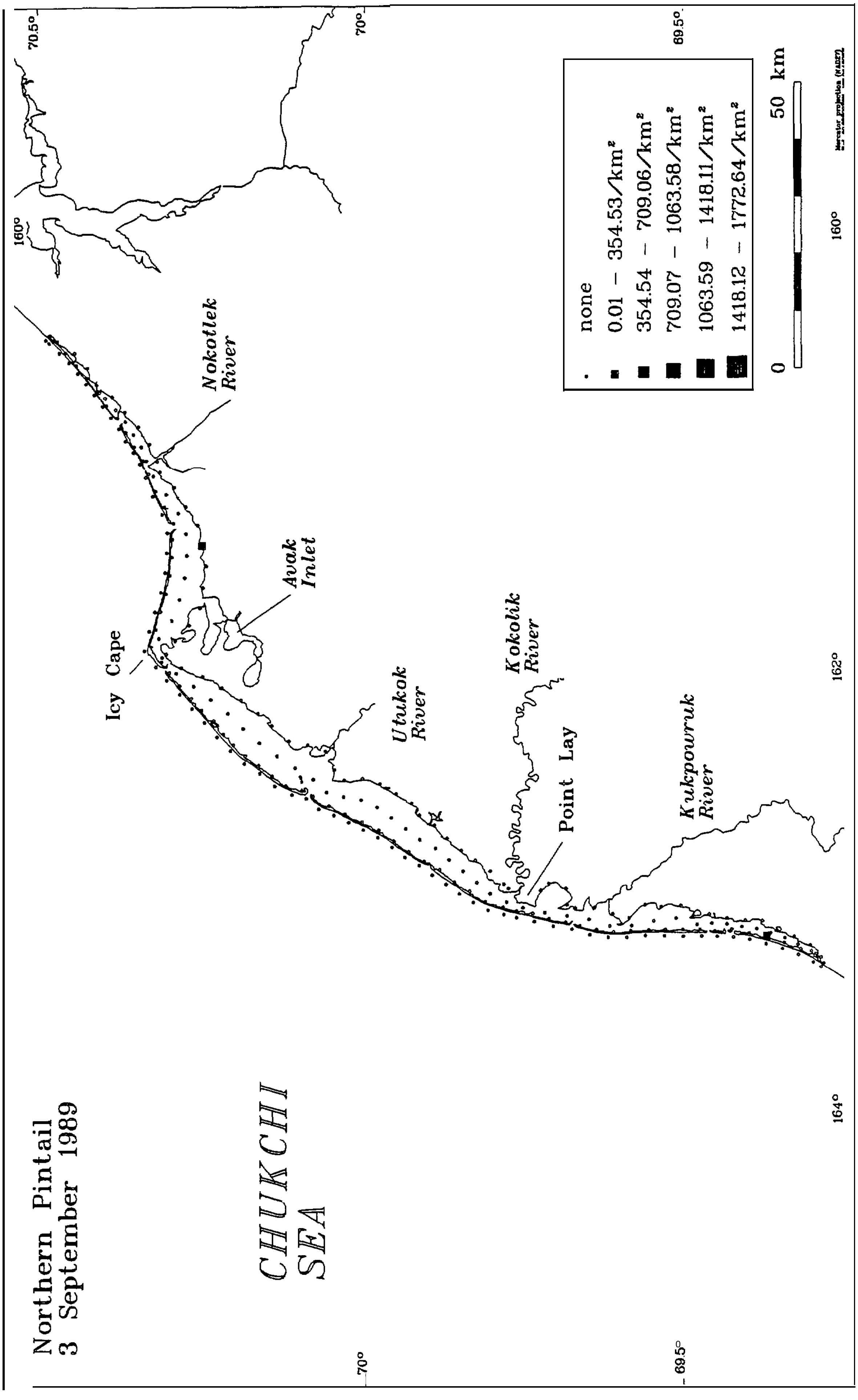
Surf Scoter
3 September 1989
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
69.5°
164°
1620
• none
0.01 – 67.44/km²
67.45 – 134.88/km'
134.89 – 202.32/km²
202,33 - 269.76/km²
269.77 - 337.20/km²
0
50 km

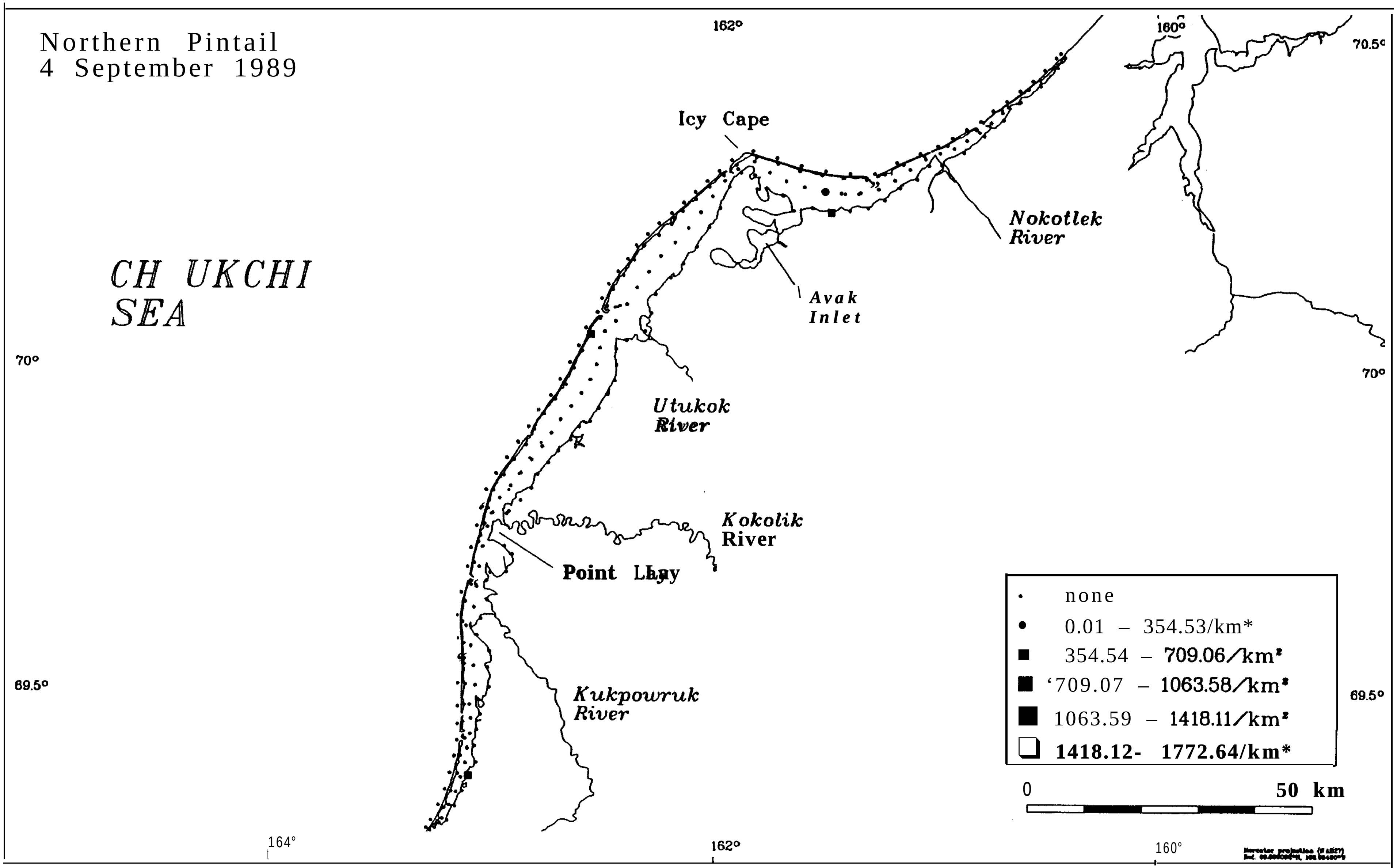

Surf Scoter
4 September 1989
162°
160°
70.5°.
Icy Cape
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
70
Utukok
River
Kokolik
River
Point Lay
•! Non-standard calculation
(see text)
none
0.01 - 67.44/km²
67.45 - 134.88/km²
134.89 - 202.32/km²
202.33 - 269.76/km²
269.77 - 337.20/km²
69.5'
69.50
Kukpowruk
River
0
50 km
160°
162°
164°

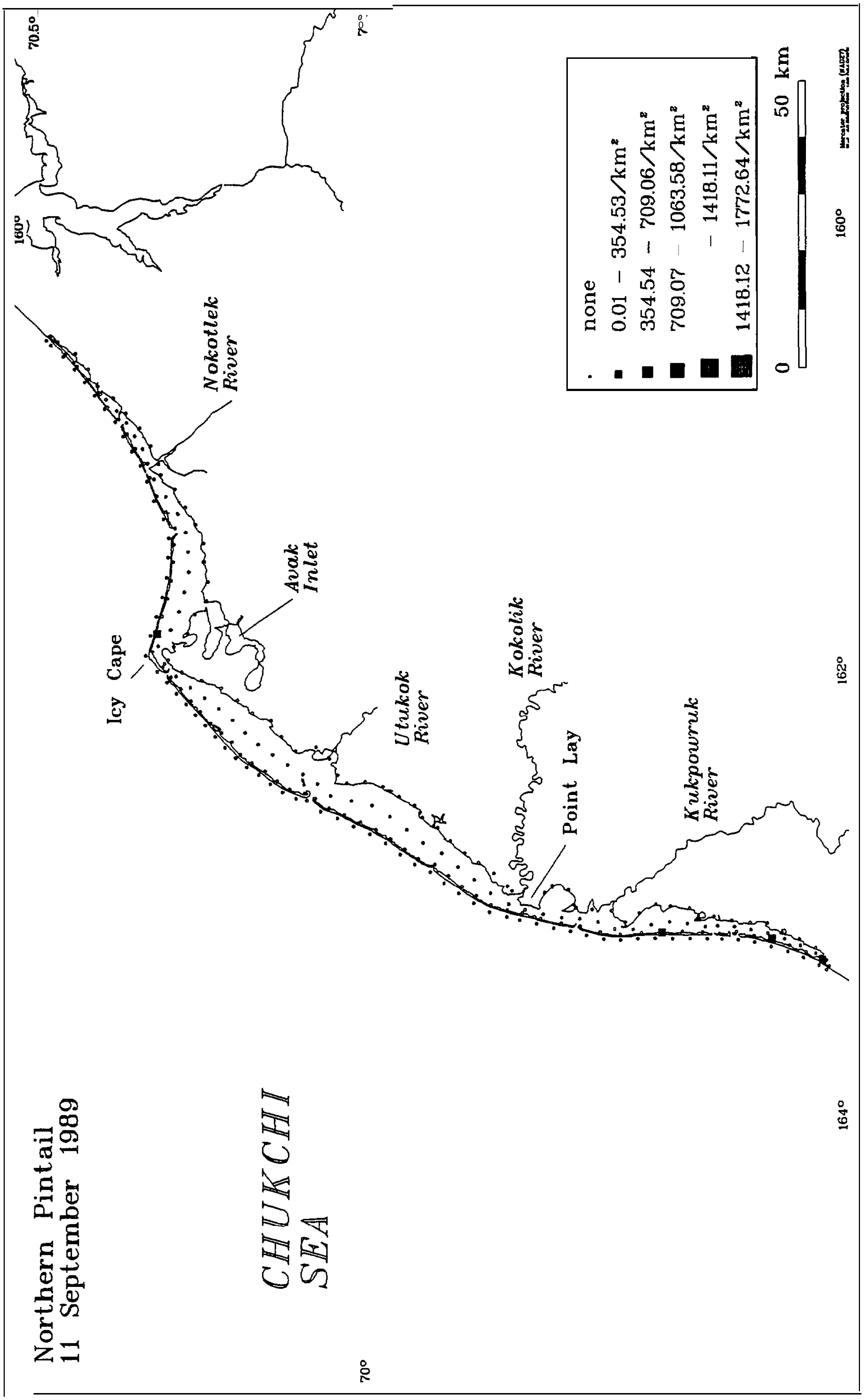

Surf Scoter
11 September 1989
CH UKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
70°
69.5°
70
164°
162°
160°
1620
• none
● 0.01 – 67.44/km*
■ 67.45 – 134.88/km²
■ 134.89 – 202.32/km²
■ 202.33 - 269.76/km'
□ 269.77 - 337.20/km'
0
50 km

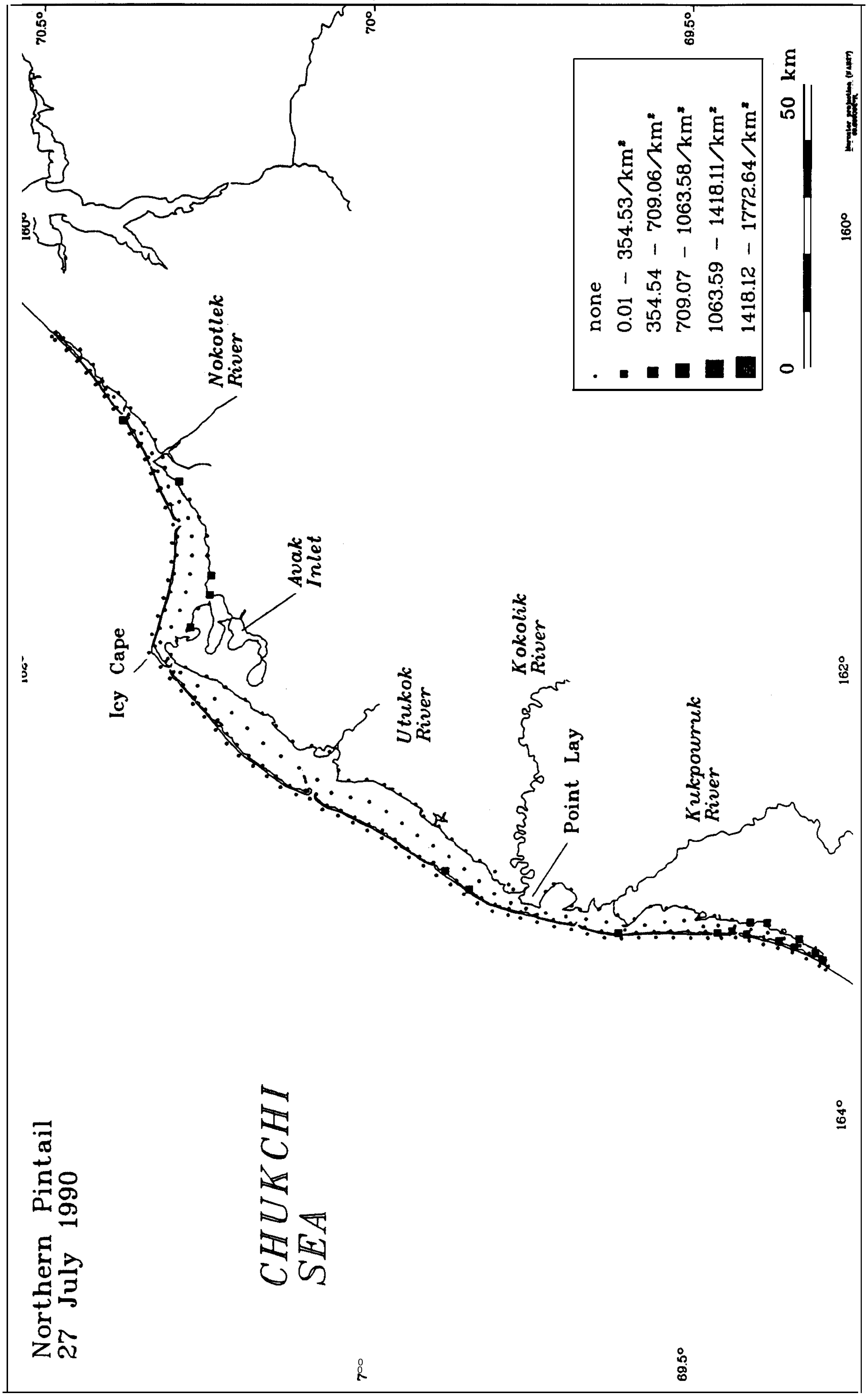

Northern Pintai
24 August 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 354.53/km²
354.54 – 709.06/km²
709.07 – 1063.58/km²
1063.59 – 1418.11/km²
1418.12 – 1772.64/km²
0
50 km
70.5°
70°
69.5
160°
162°
70°
69.5°

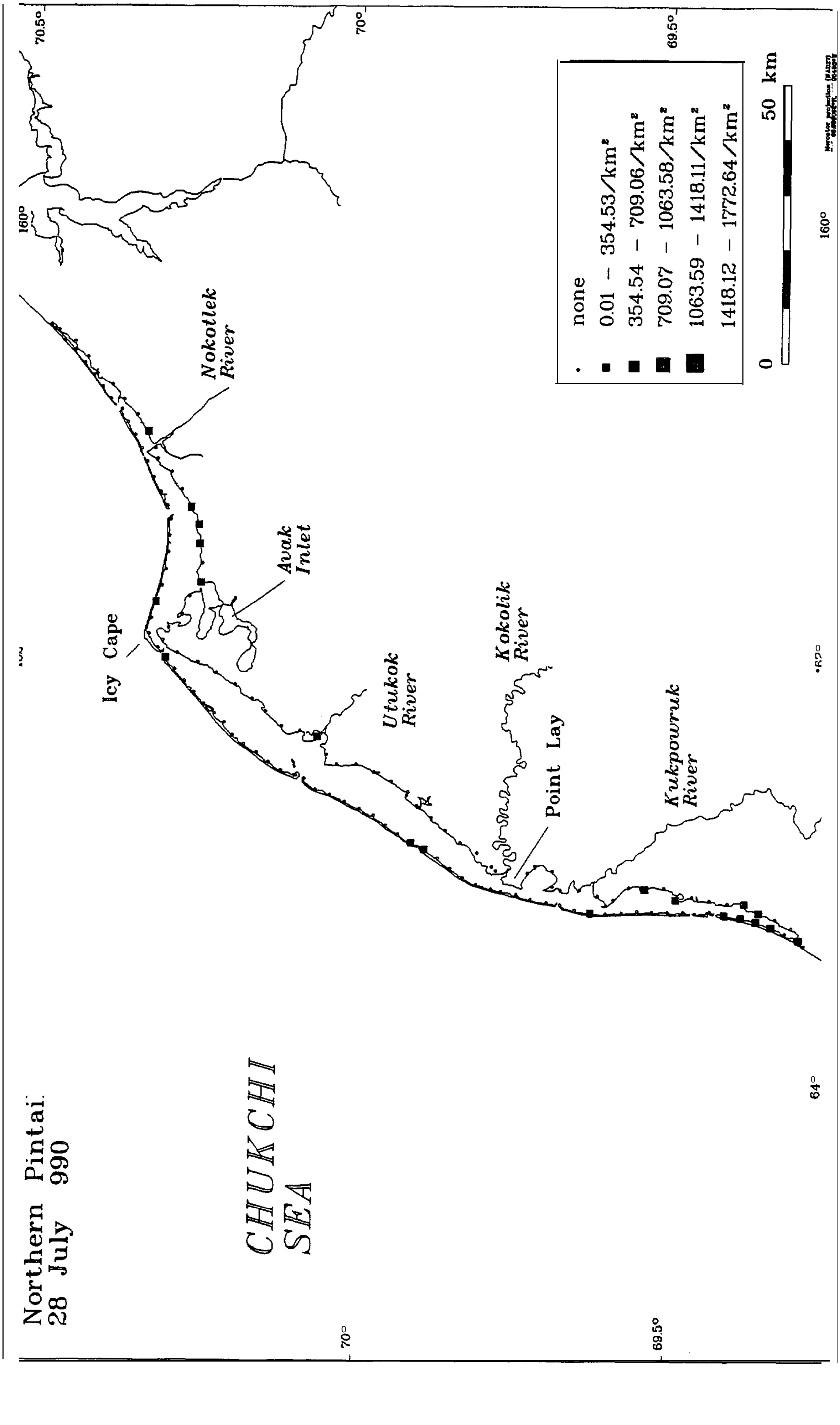

Northern Pintail
26 Augus . 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 354.53/km²
354.54 – 709.06/km²
709.07 – 1063.58/km²
1063.59 – 1418.11/km²
418.12 – 1772.64/km²
0
50 km
70.5°
70°
69.5°
160°

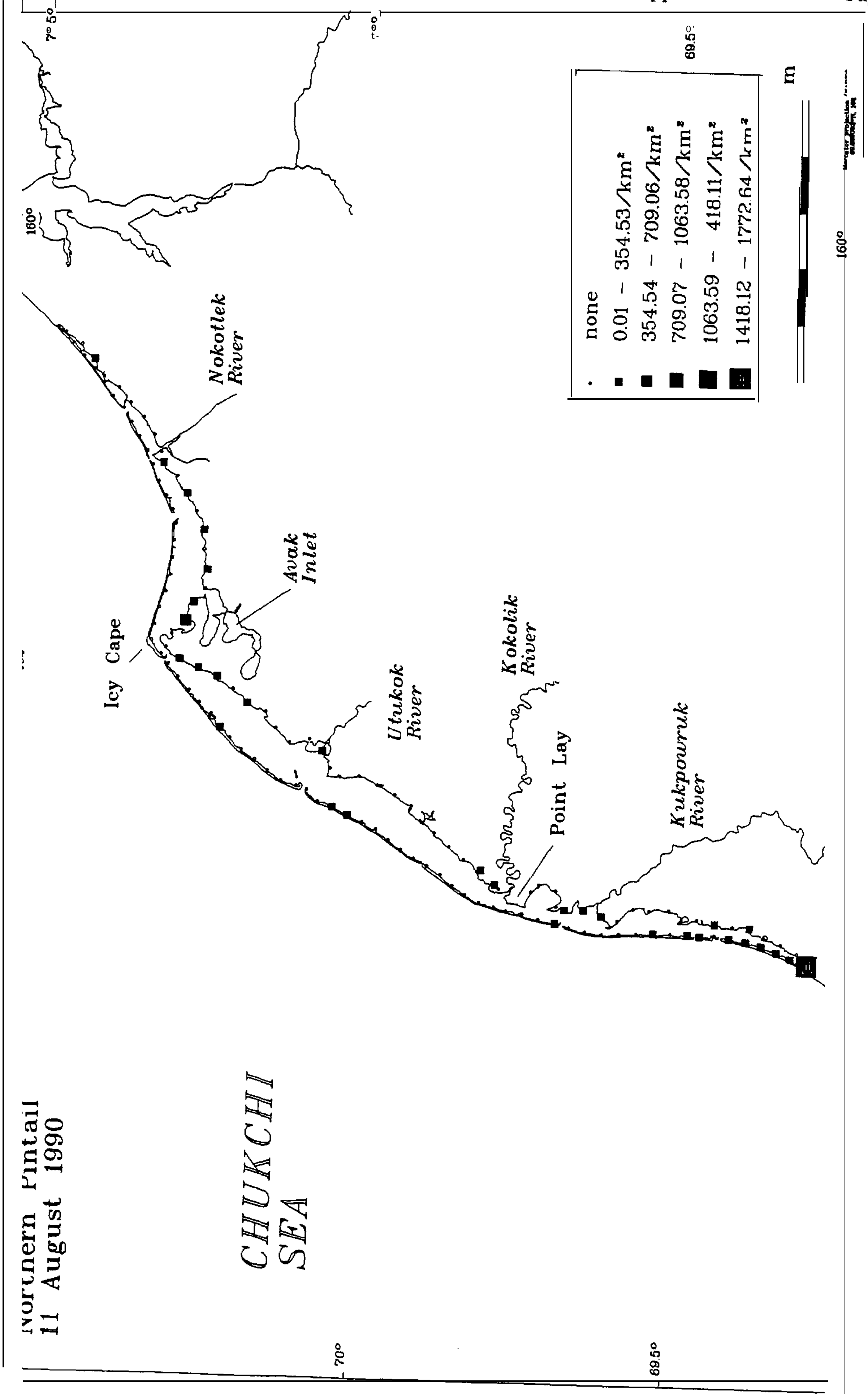

Northern Pintail
3 September 1989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukak
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 354.53/km²
354.54 – 709.06/km²
709.07 – 1063.58/km²
1063.59 – 1418.11/km²
1418.12 – 1772.64/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

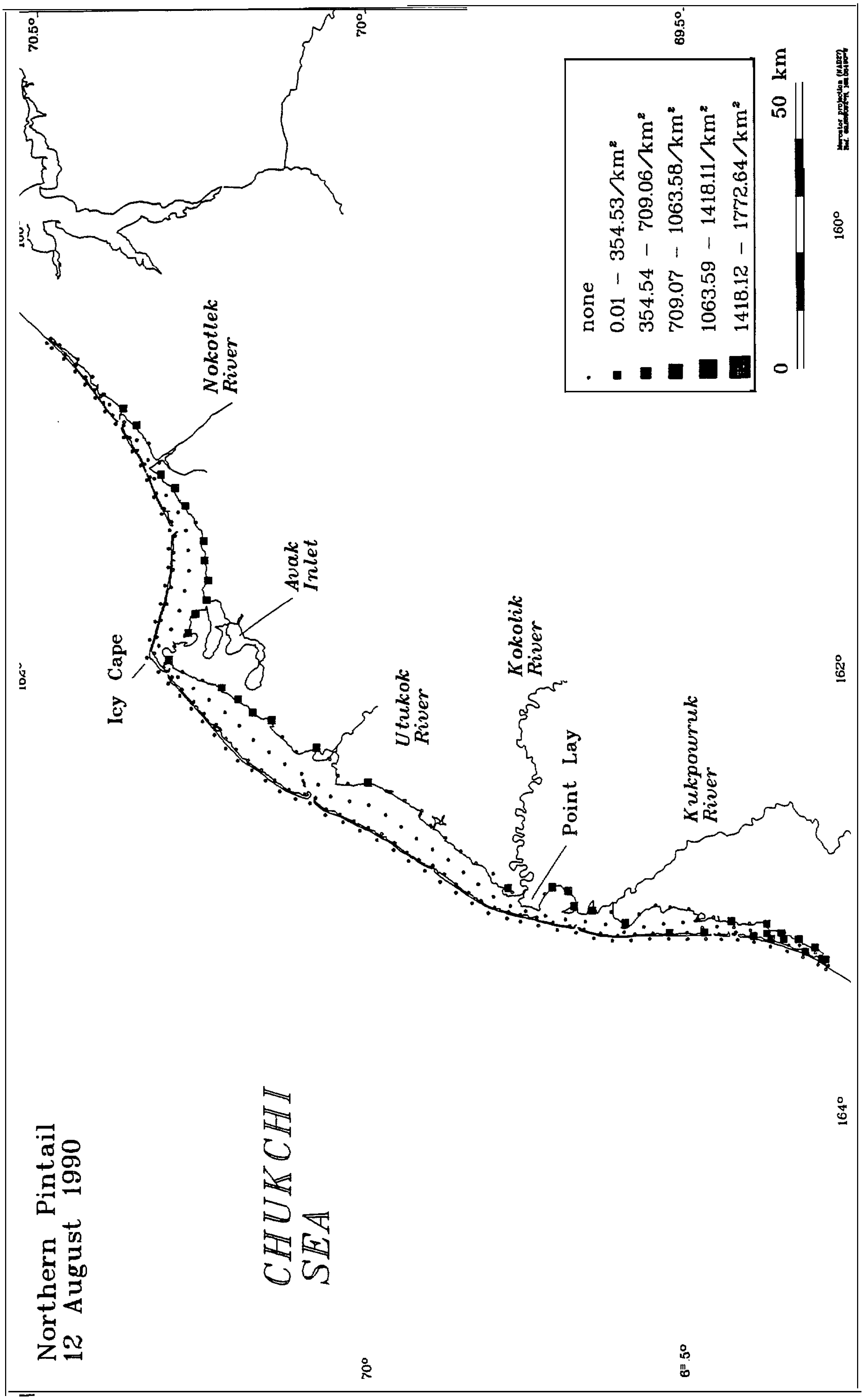

Northern Pintail
4 September 1989
CH UKCHI SEA
Icy Cape
Avak Inlet
Nokotlek River
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 354.53/km*
354.54 – 709.06/km²
709.07 – 1063.58/km²
1063.59 – 1418.11/km²
1418.12- 1772.64/km*
0
50 km
162°
160°
164°
70.5°
70°
69.5°

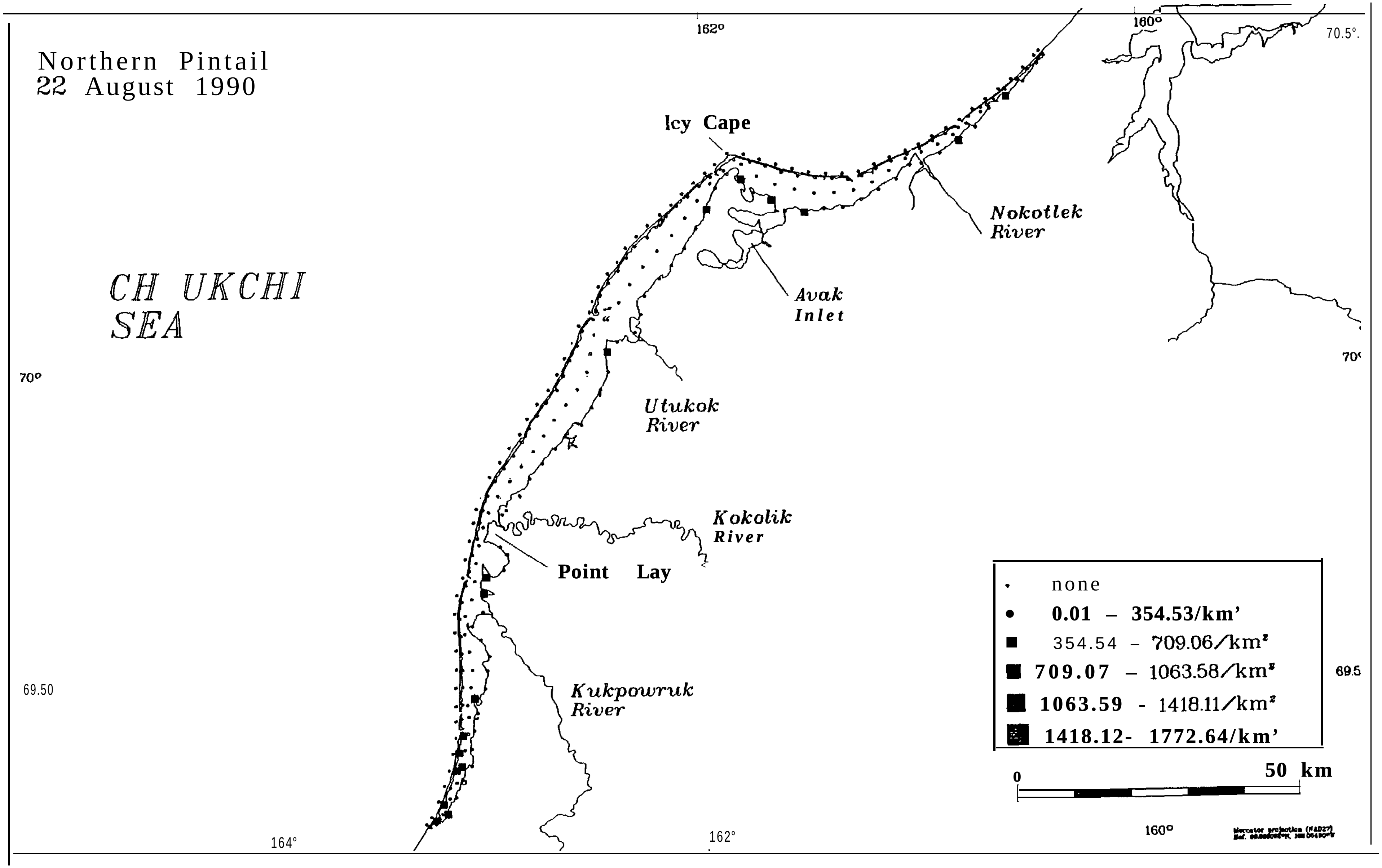

Northern Pintail
11 September 1989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 354.53/km²
354.54 – 709.06/km²
709.07 – 1063.58/km²
– 1418.11/km²
1418.12 – 1772.64/km²
0
50 km
70.5°
70°
160°
162°
164°


Northern Pintail
27 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 354.53/km^2
354.54 – 709.06/km^2
709.07 – 1063.58/km^2
1063.59 – 1418.11/km^2
1418.12 – 1772.64/km^2
0
50 km
70.5°
70°
69.5°
160°
162°
164°

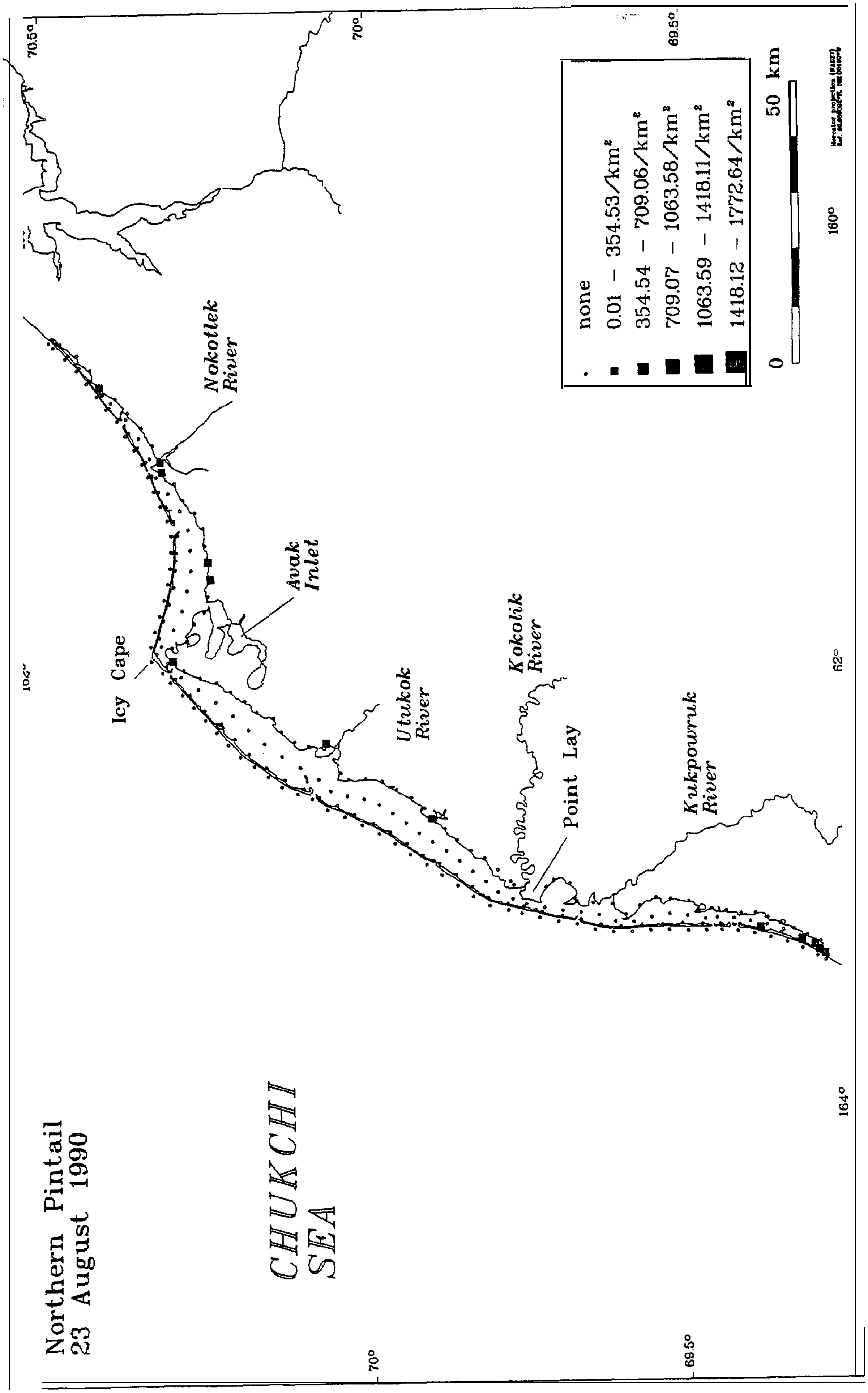

Northern Pintai
28 July 990
CHUKCHI
SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 354.53/km²
354.54 – 709.06/km²
709.07 – 1063.58/km²
1063.59 – 1418.11/km²
1418.12 – 1772.64/km²
0
50 km
70.5°
70°
69.5°
160°
164°

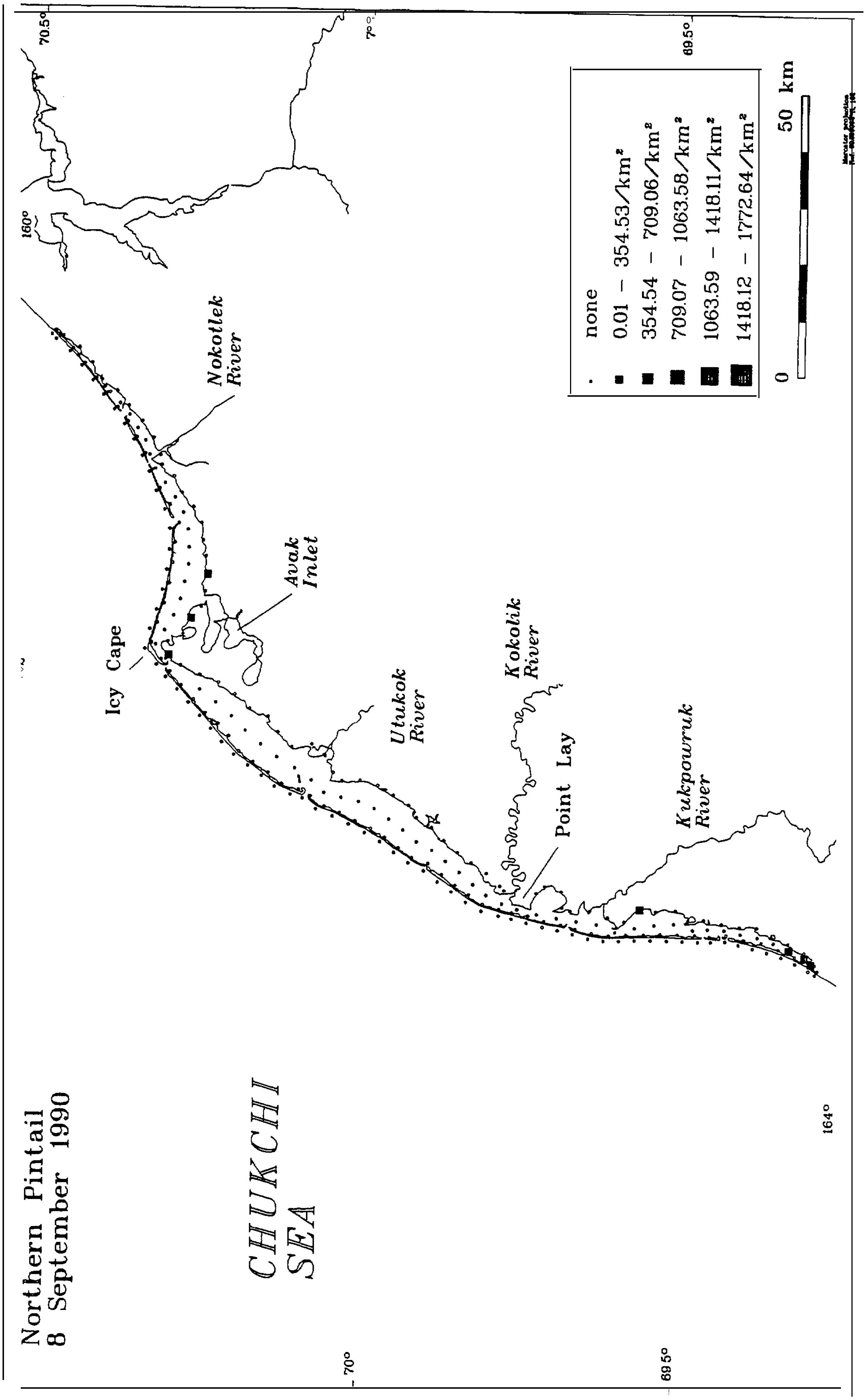

Northern Pintail
11 August 1990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 354.53/km²
354.54 - 709.06/km²
709.07 - 1063.58/km²
1063.59 - 418.11/km²
1418.12 - 1772.64/km²
70°
69.5°
160°

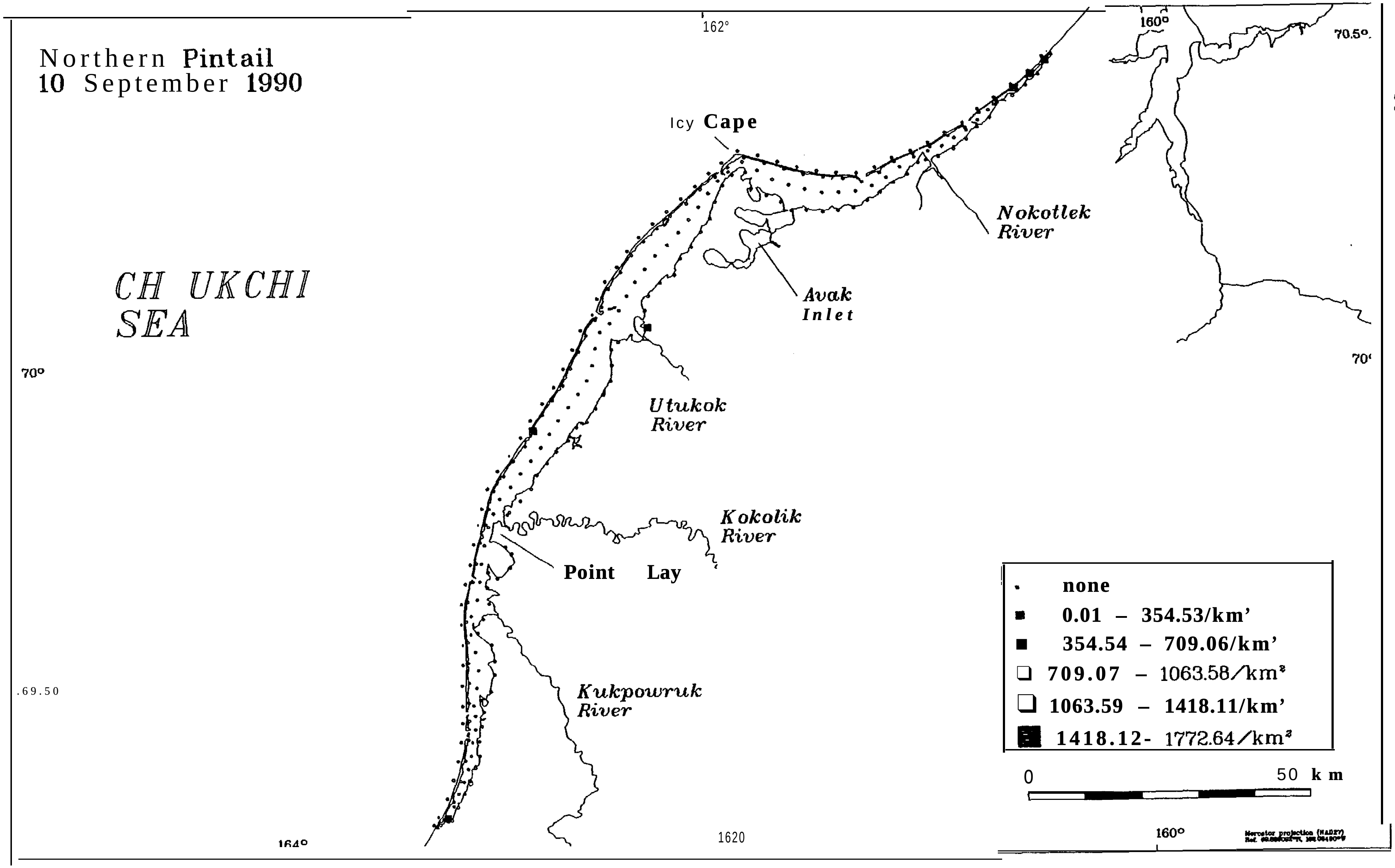

Northern Pintail
12 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 354.53/km²
354.54 - 709.06/km²
709.07 - 1063.58/km²
1063.59 - 1418.11/km²
1418.12 - 1772.64/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

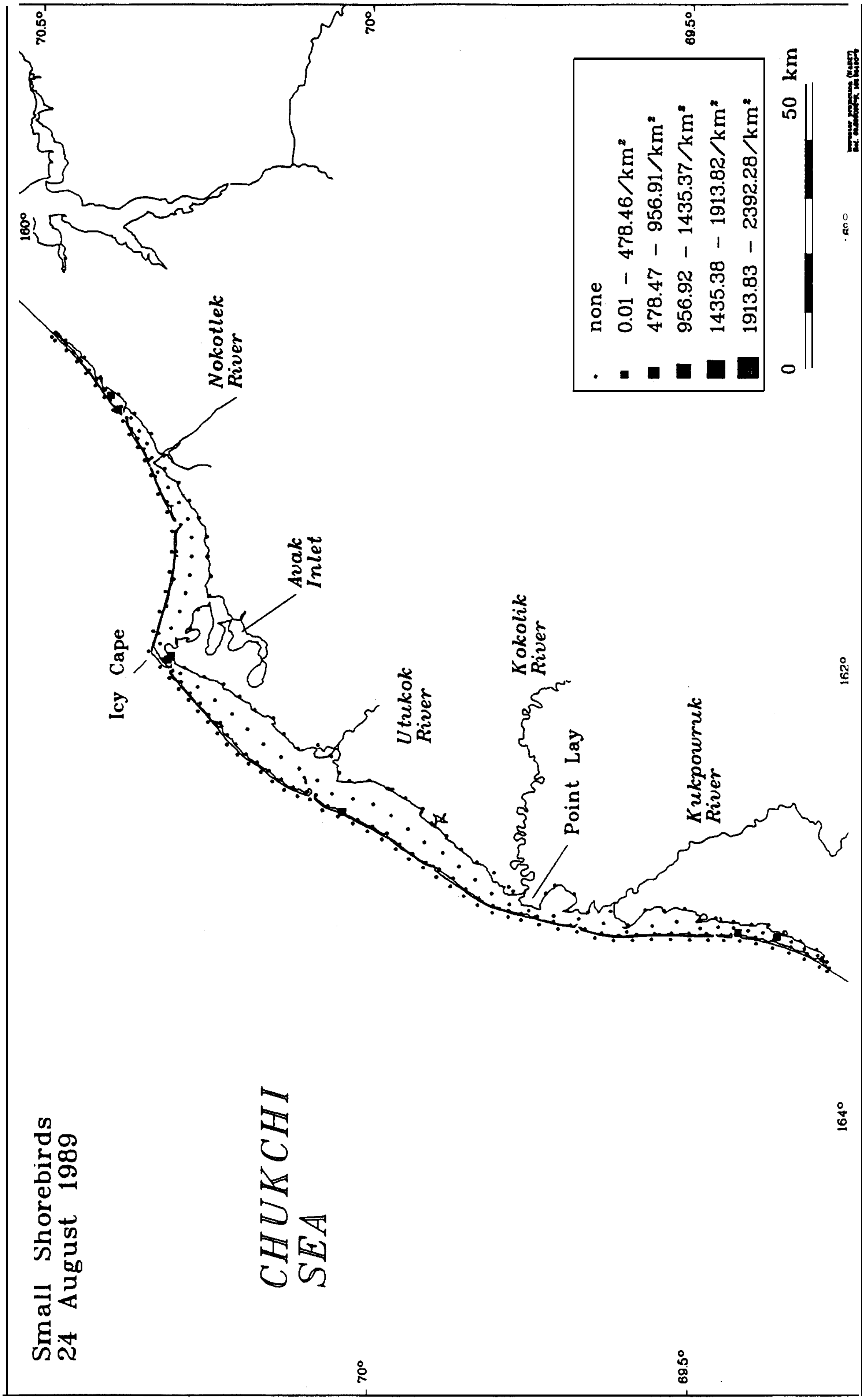


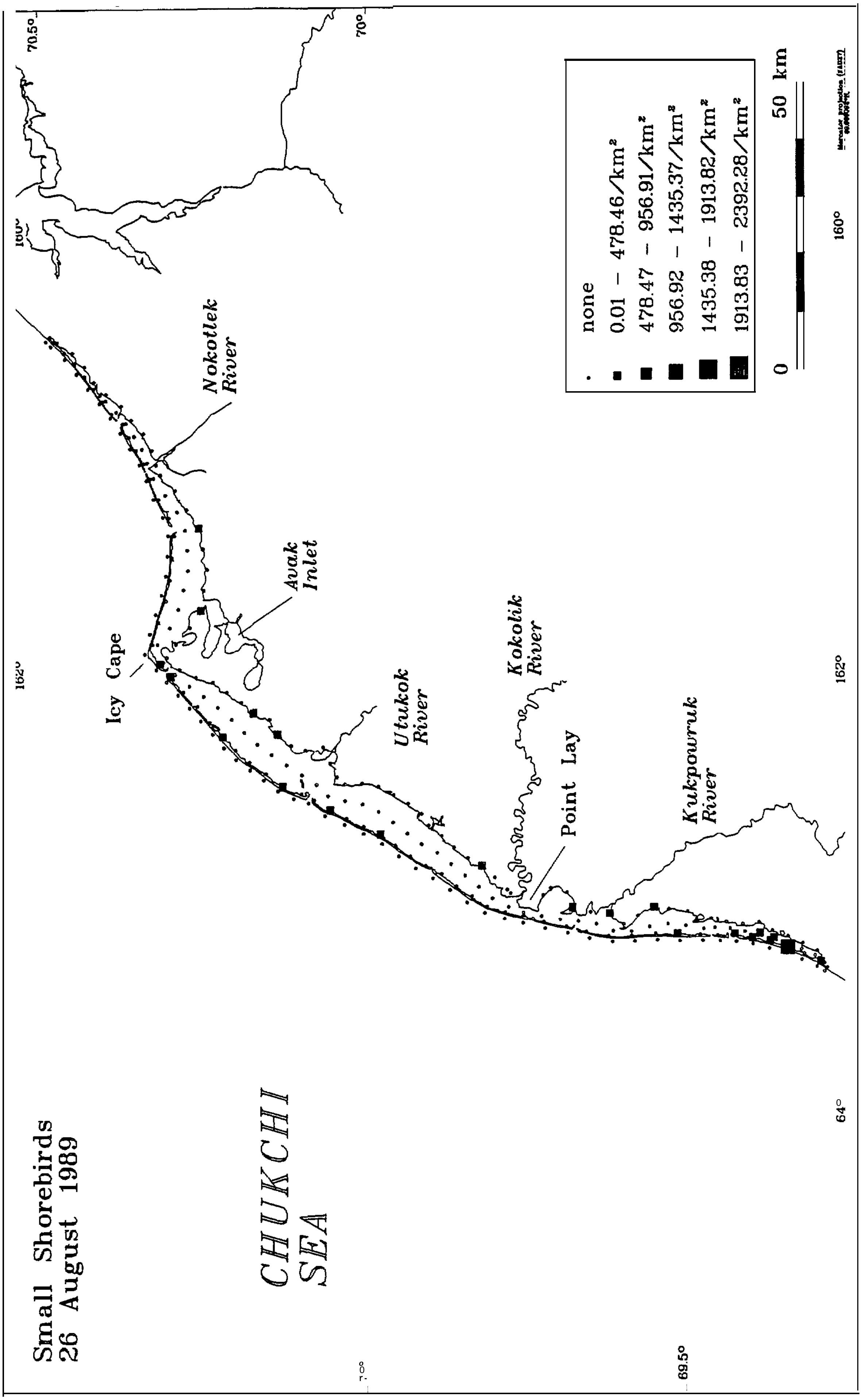
Northern Pintail
22 August 1990
Icy Cape
Nokotlek
River
Avak
Inlet
CH UKCHI
SEA
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
160°
70.5°
70°
69.5
69.50
164°
none
0.01 – 354.53/km’
354.54 – 709.06/km²
709.07 – 1063.58/km²
1063.59 - 1418.11/km²
1418.12- 1772.64/km’
0
50 km

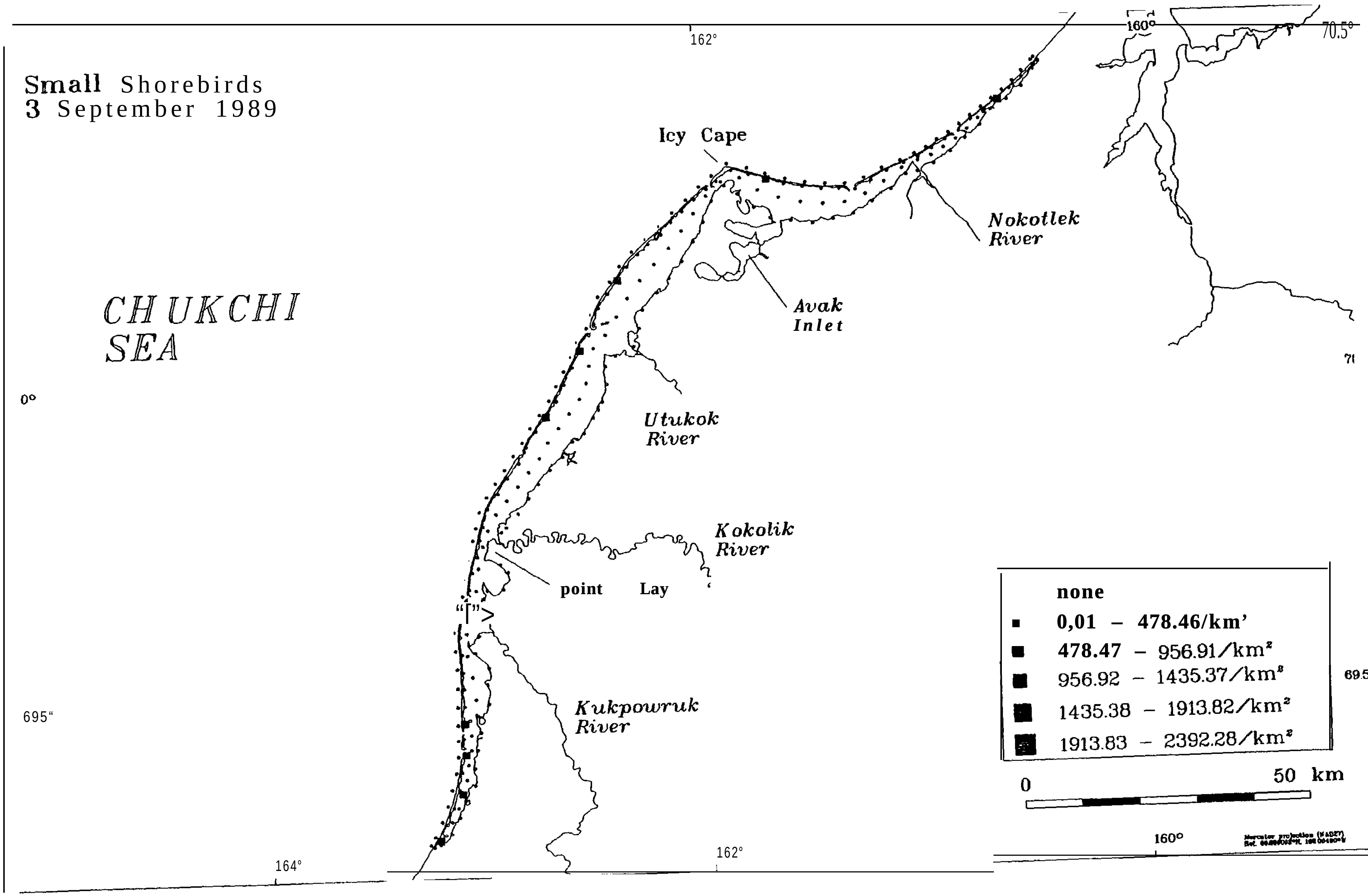

Northern Pintail
23 August 1990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 354.53/km²
354.54 - 709.06/km²
709.07 - 1063.58/km²
1063.59 - 1418.11/km²
1418.12 - 1772.64/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

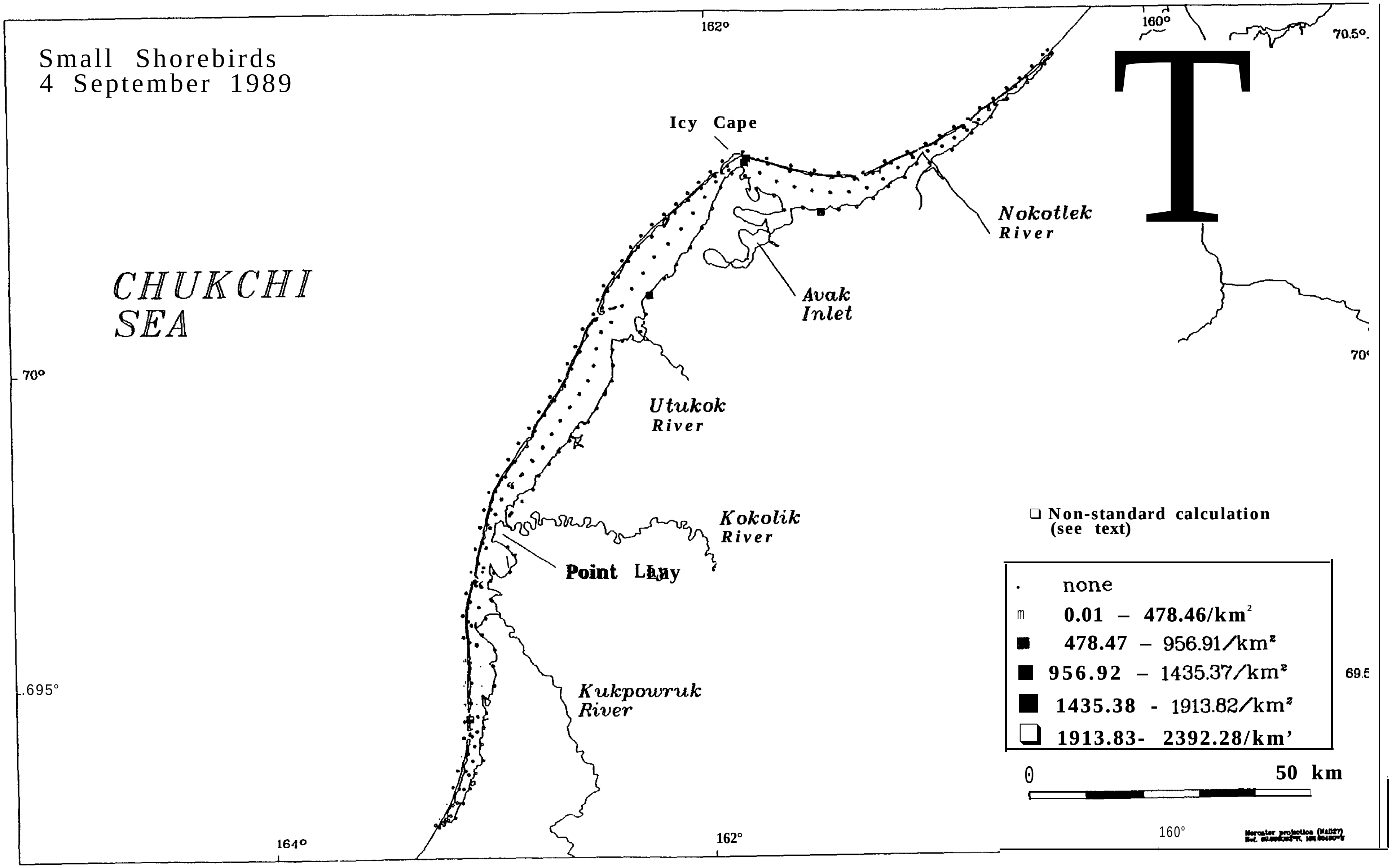

Northern Pintail
8 September 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 354.53/km²
354.54 – 709.06/km²
709.07 – 1063.58/km²
1063.59 – 1418.11/km²
1418.12 – 1772.64/km²
0
50 km
70.5°
70°
69.5°
160°
164°
70°
69.5°

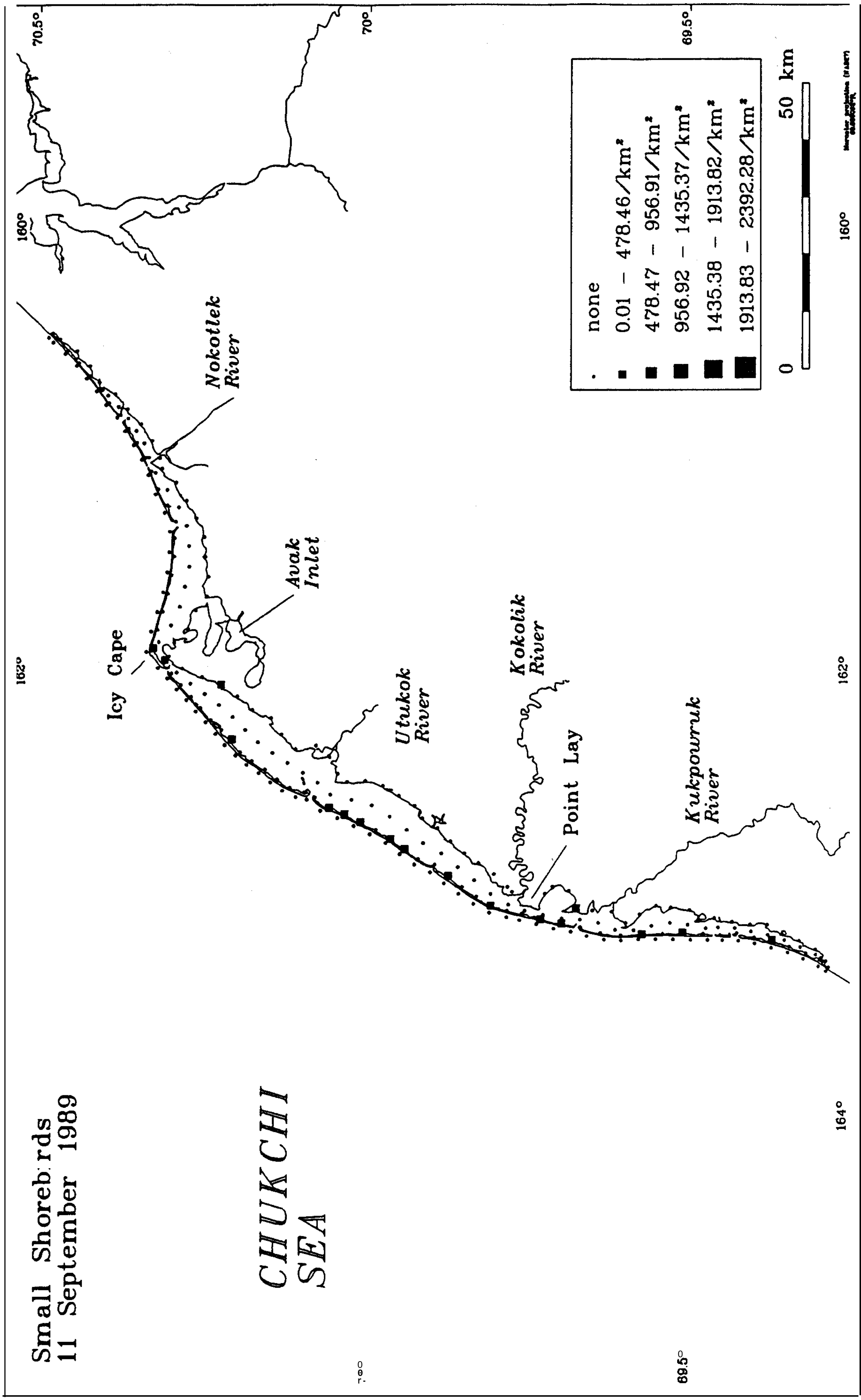

Northern Pintail
10 September 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
69.50
164°
1620
none
0.01 – 354.53/km'
354.54 – 709.06/km'
709.07 – 1063.58/km²
1063.59 – 1418.11/km'
1418.12- 1772.64/km²
0
50 km

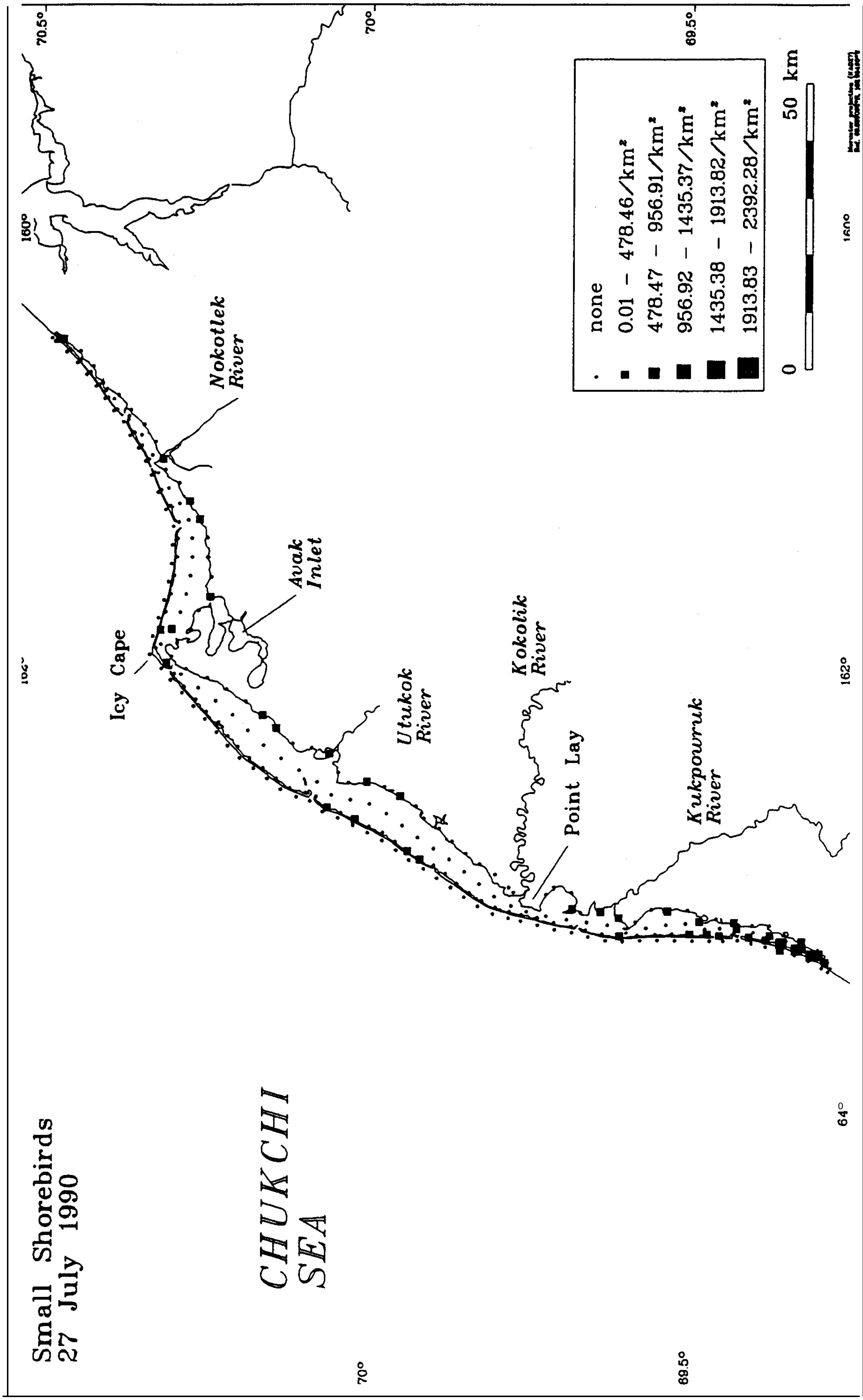

Small Shorebirds
24 August 1989
CHUKCHI
SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 478.46/km²
478.47 – 956.91/km²
956.92 – 1435.37/km²
1435.38 – 1913.82/km²
1913.83 – 2392.28/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

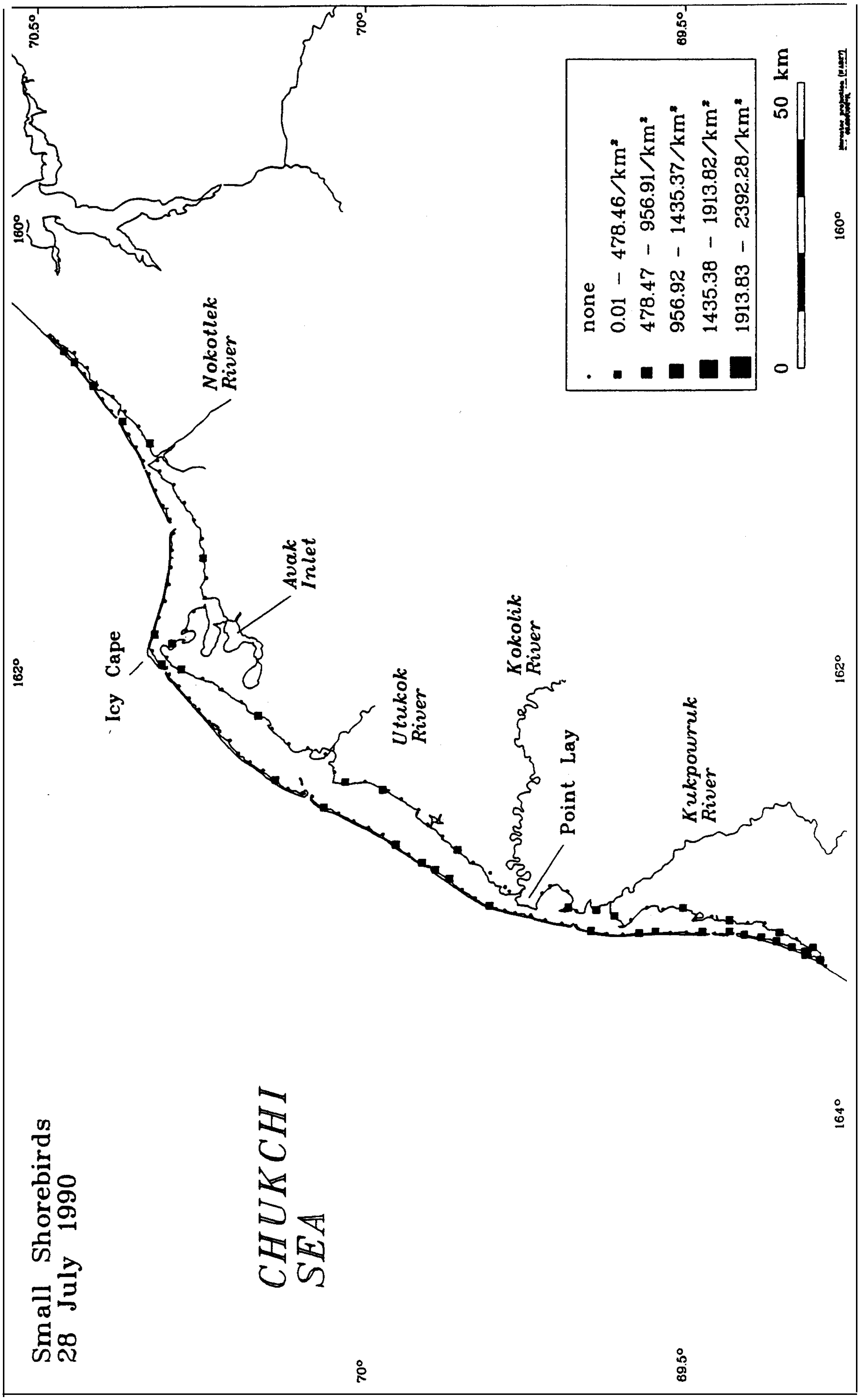

Small Shorebirds
26 August 1989
CHUKCHI
SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 478.46/km²
478.47 - 956.91/km²
956.92 - 1435.37/km²
1435.38 - 1913.82/km²
1913.83 - 2392.28/km²
0
50 km
70.5°
70°
162°
160°
64°
69.5°

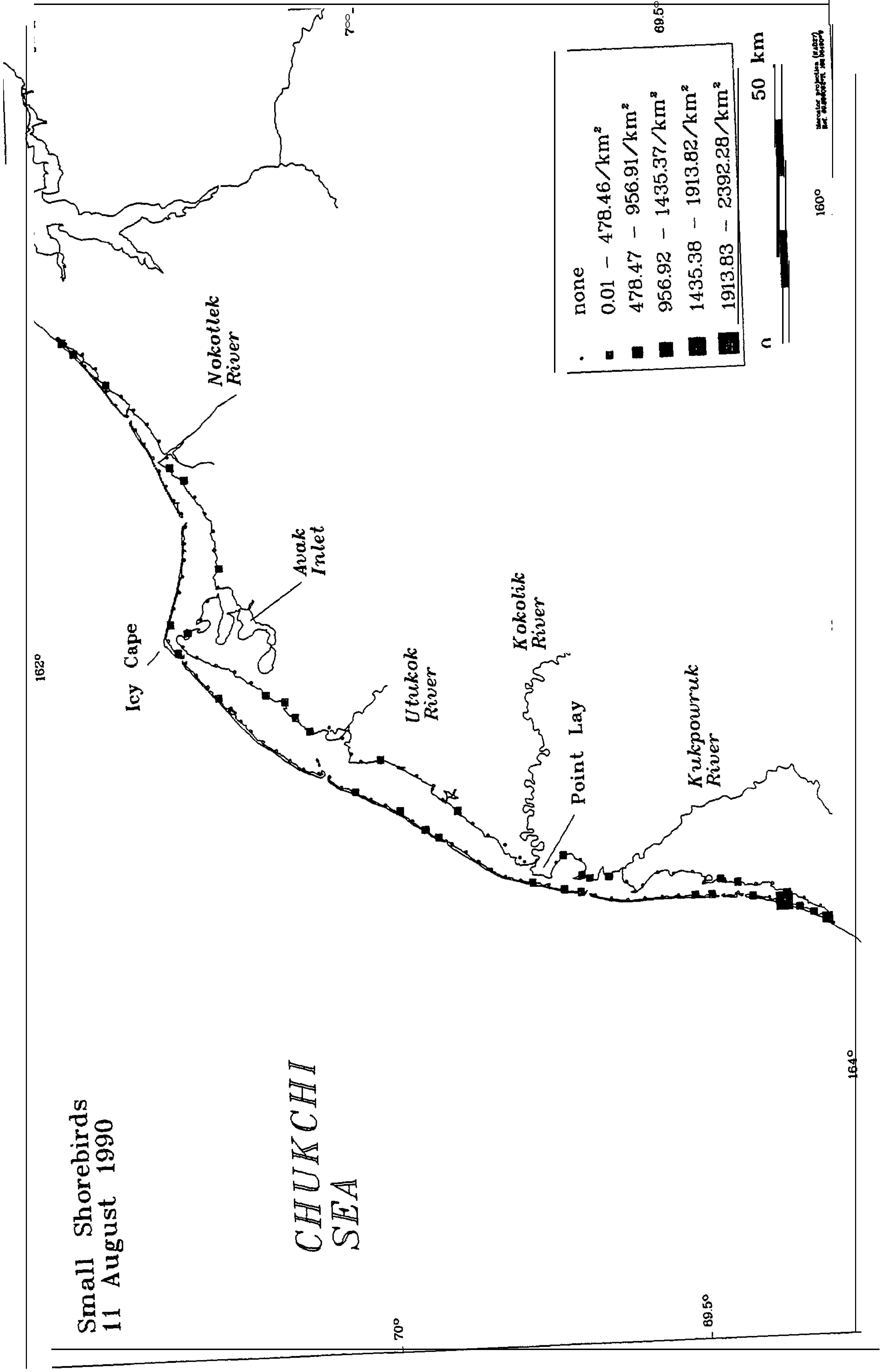

Small Shorebirds
3 September 1989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
point Lay
Kukpowruk
River
none
0,01 – 478.46/km'
478.47 – 956.91/km²
956.92 – 1435.37/km²
1435.38 – 1913.82/km²
1913.83 – 2392.28/km²
0
50 km
162°
160°
164°
70.5°
695"
69.5


Small Shorebirds
4 September 1989
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
69.5
.695°
164°
Non-standard calculation (see text)
none
0.01 – 478.46/km²
478.47 – 956.91/km²
956.92 – 1435.37/km²
1435.38 - 1913.82/km²
1913.83- 2392.28/km'
0 50 km

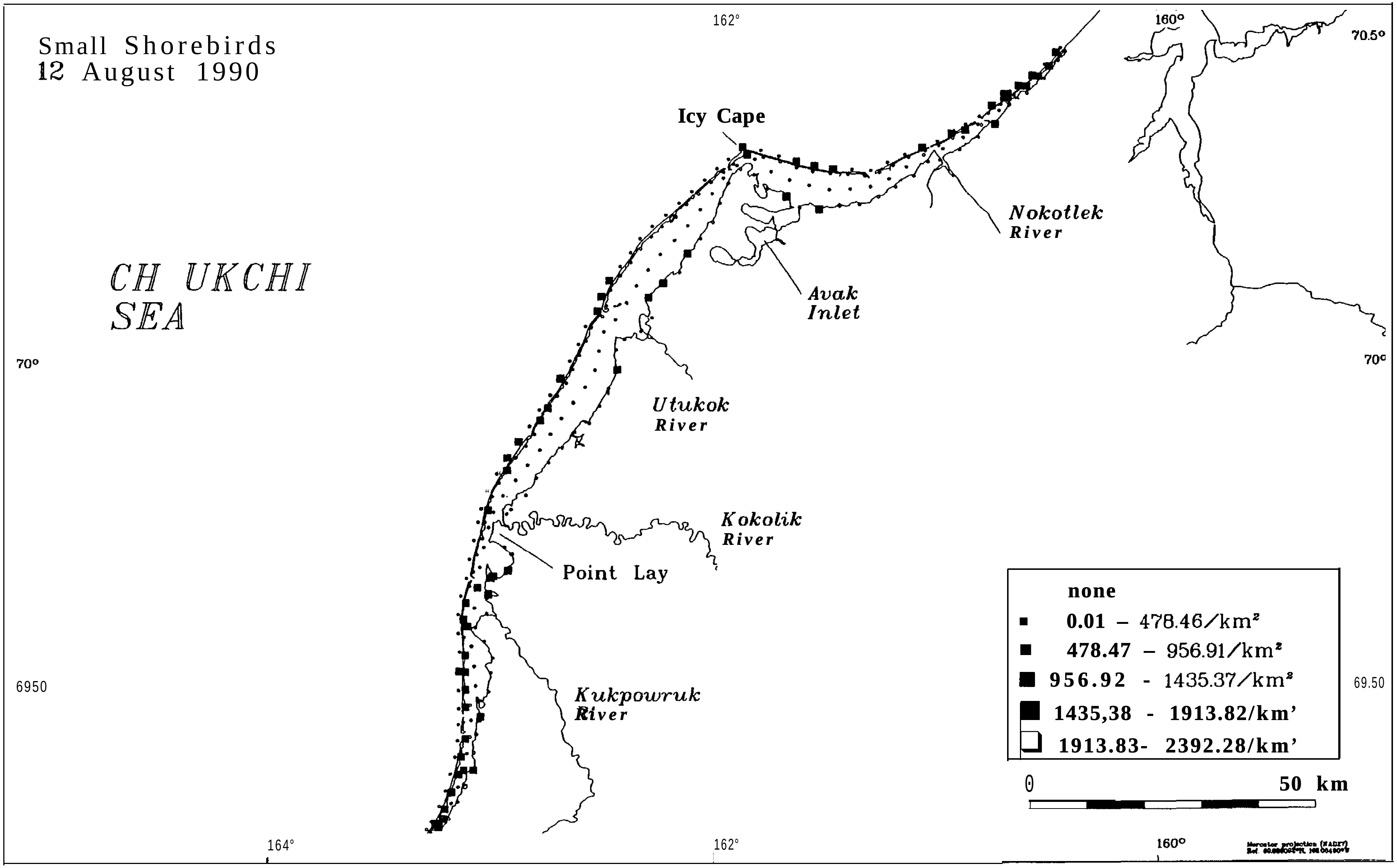

Small Shorebirds
11 September 1989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 478.46/km²
478.47 – 956.91/km²
956.92 – 1435.37/km²
1435.38 – 1913.82/km²
1913.83 – 2392.28/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

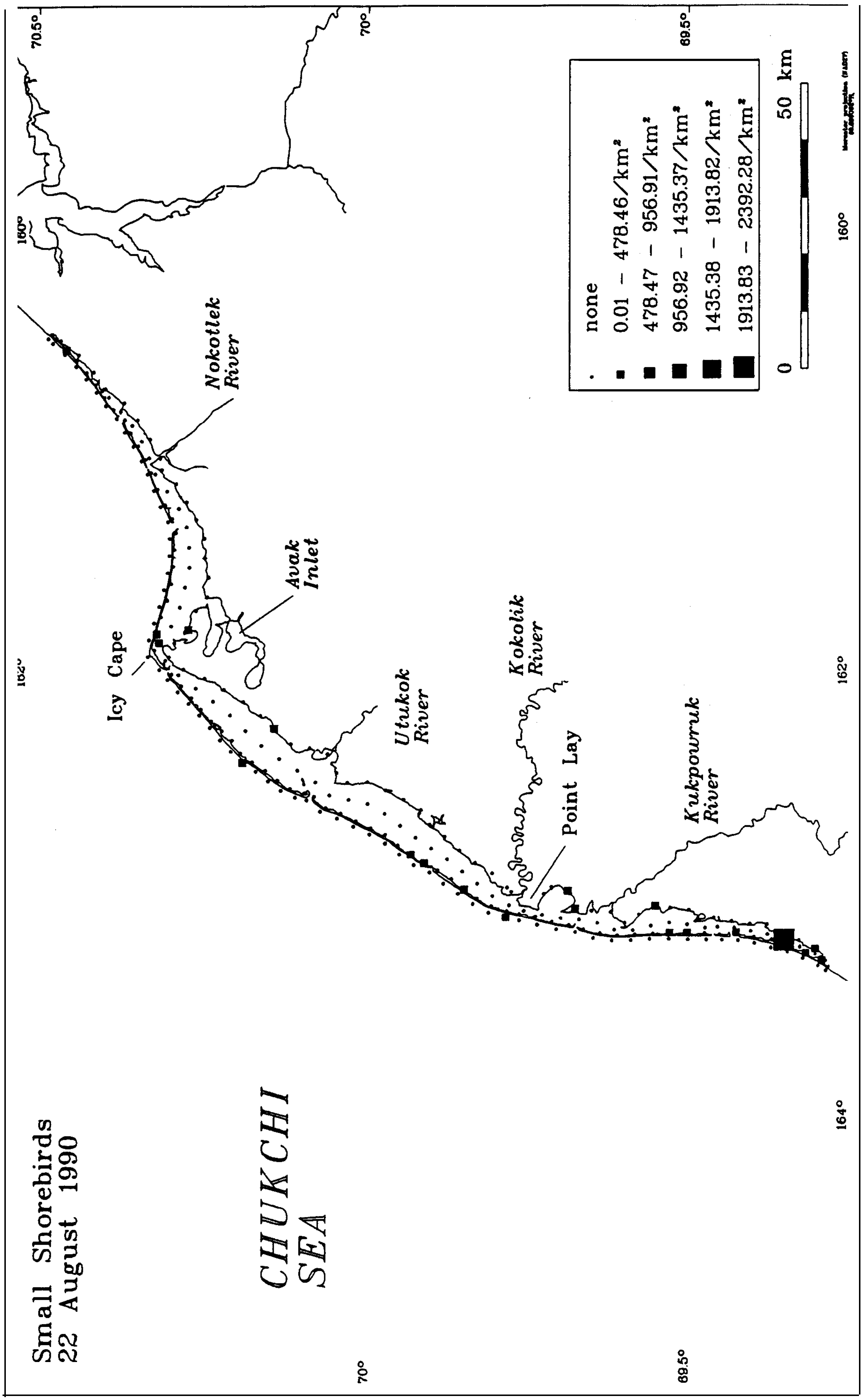

Small Shorebirds
27 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 478.46/km²
478.47 - 956.91/km²
956.92 - 1435.37/km²
1435.38 - 1913.82/km²
1913.83 - 2392.28/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°


Small Shorebirds
28 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 478.46/km²
478.47 – 956.91/km²
956.92 – 1435.37/km²
1435.38 – 1913.82/km²
1913.83 – 2392.28/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

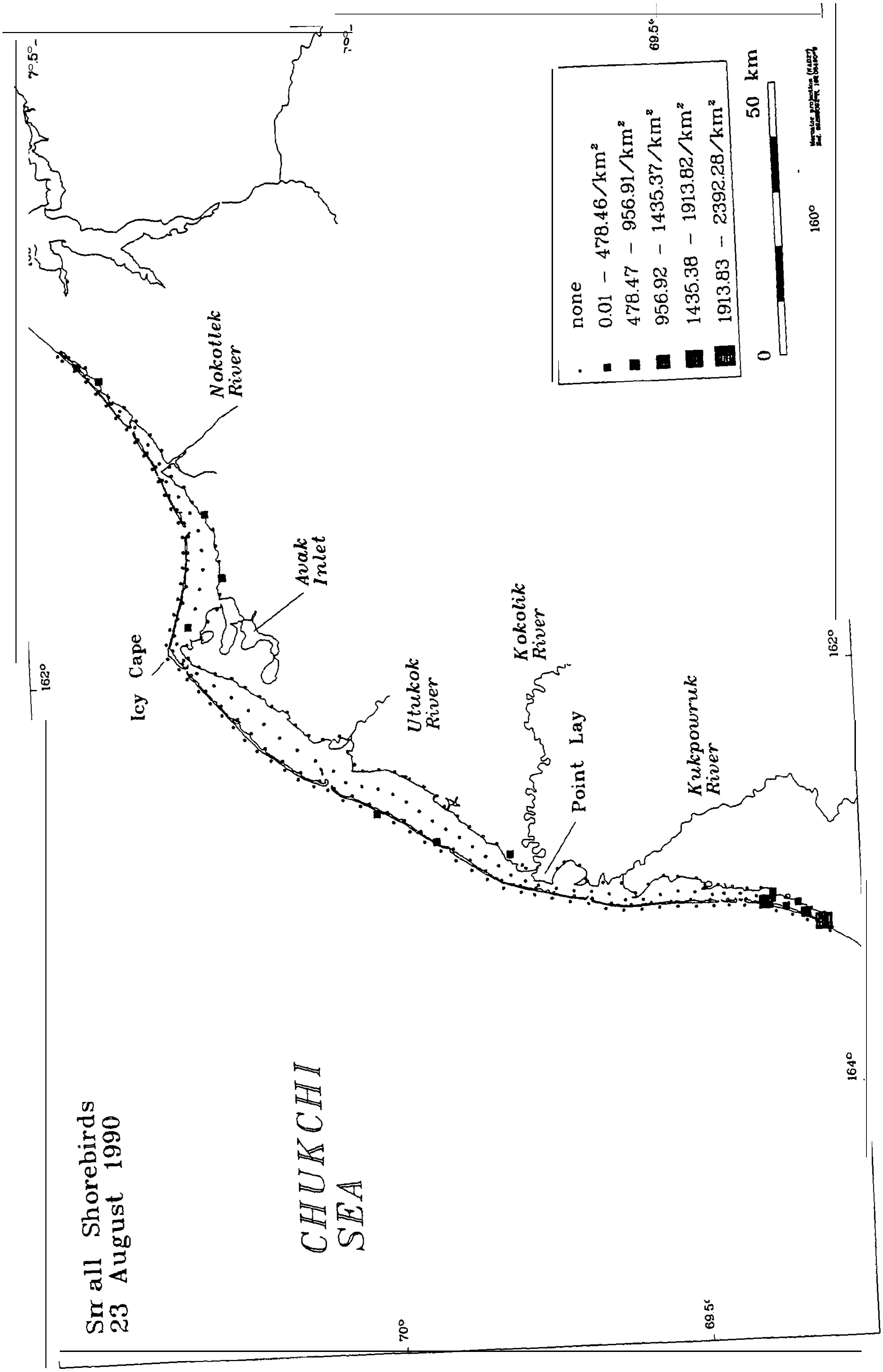


Small Shorebirds
11 August 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 478.46/km²
478.47 - 956.91/km²
956.92 - 1435.37/km²
1435.38 - 1913.82/km²
1913.83 - 2392.28/km²
0
50 km
70°
69.5°
162°
164°
160°

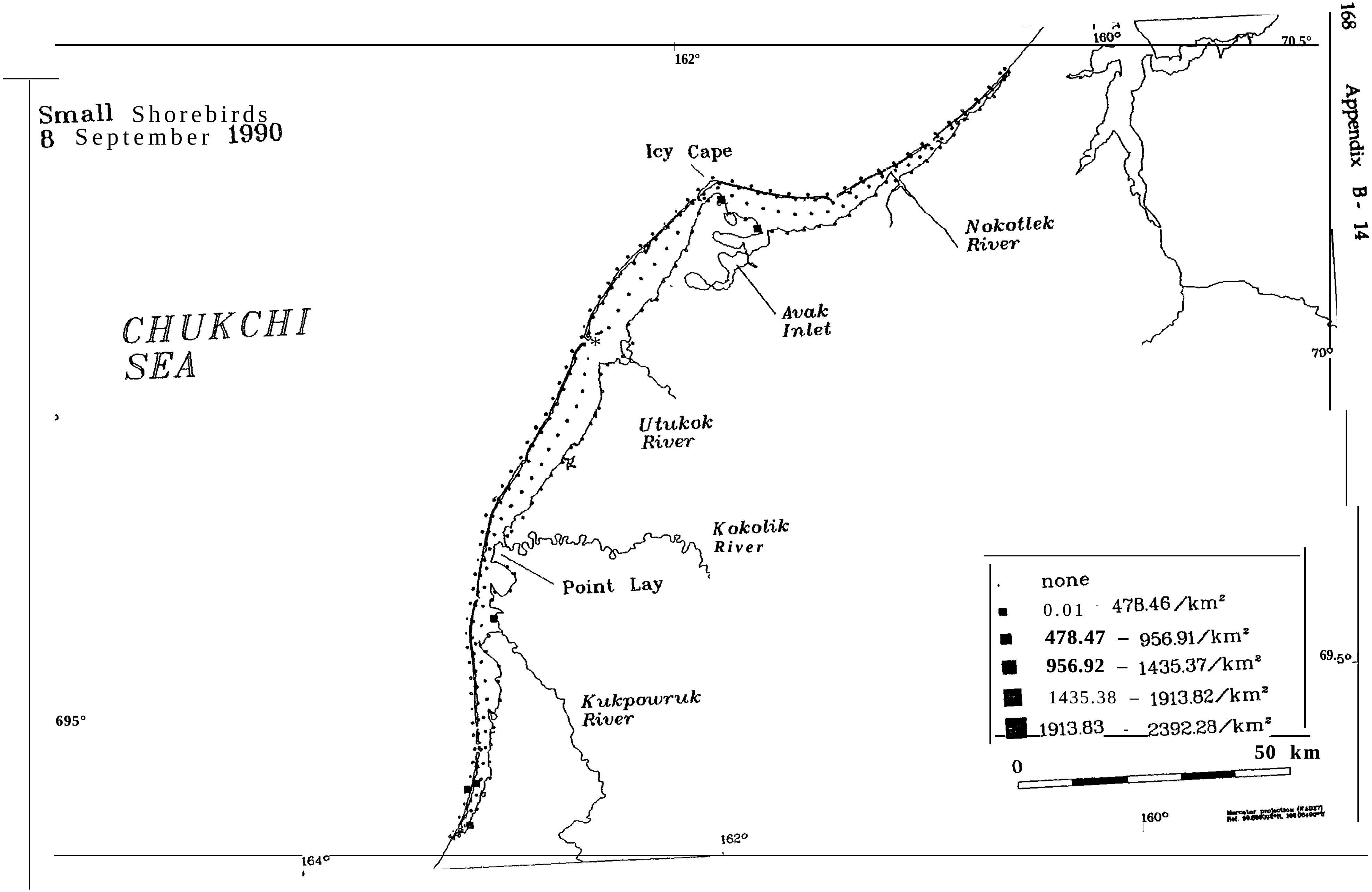

Small Shorebirds
12 August 1990
CH UKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
160°
164°
70.5°
70°
6950
69.50
none
0.01 – 478.46/km²
478.47 – 956.91/km²
956.92 - 1435.37/km²
1435,38 - 1913.82/km'
1913.83- 2392.28/km'
0
50 km

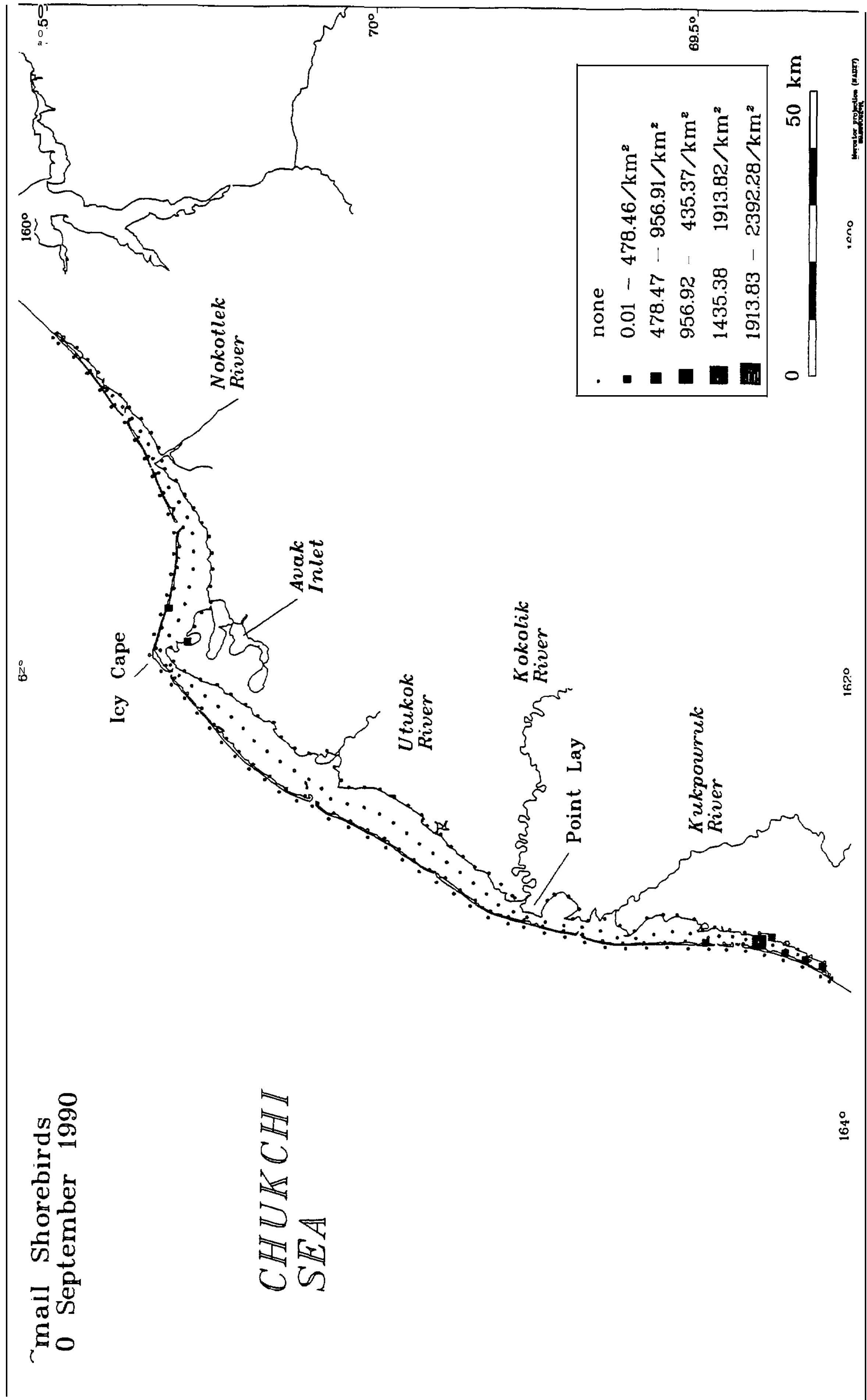


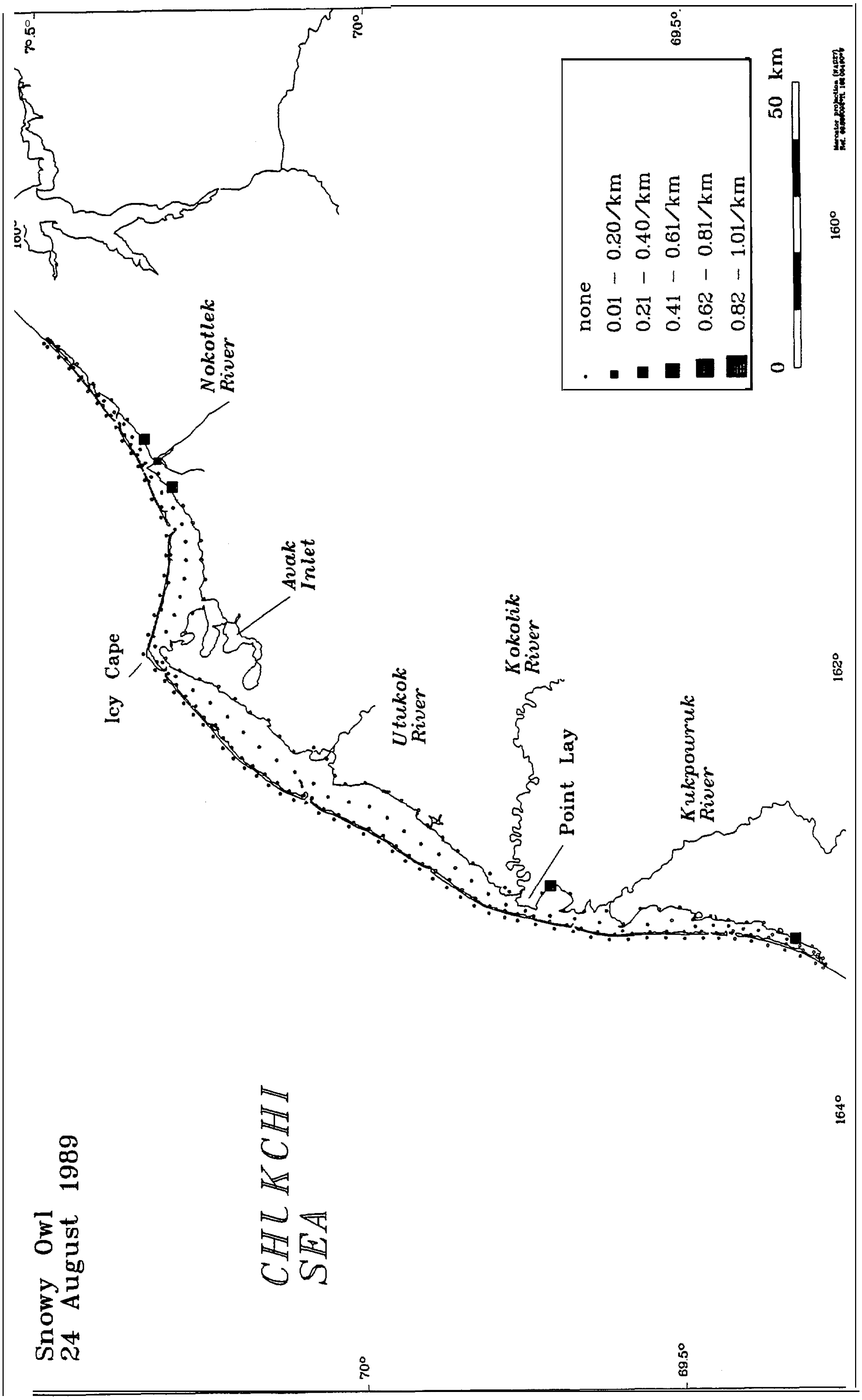
Small Shorebirds
22 August 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Kokolik
River
Utukok
River
Point Lay
Kukpowruk
River
none
0.01 - 478.46/km²
478.47 - 956.91/km²
956.92 - 1435.37/km²
1435.38 - 1913.82/km²
1913.83 - 2392.28/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

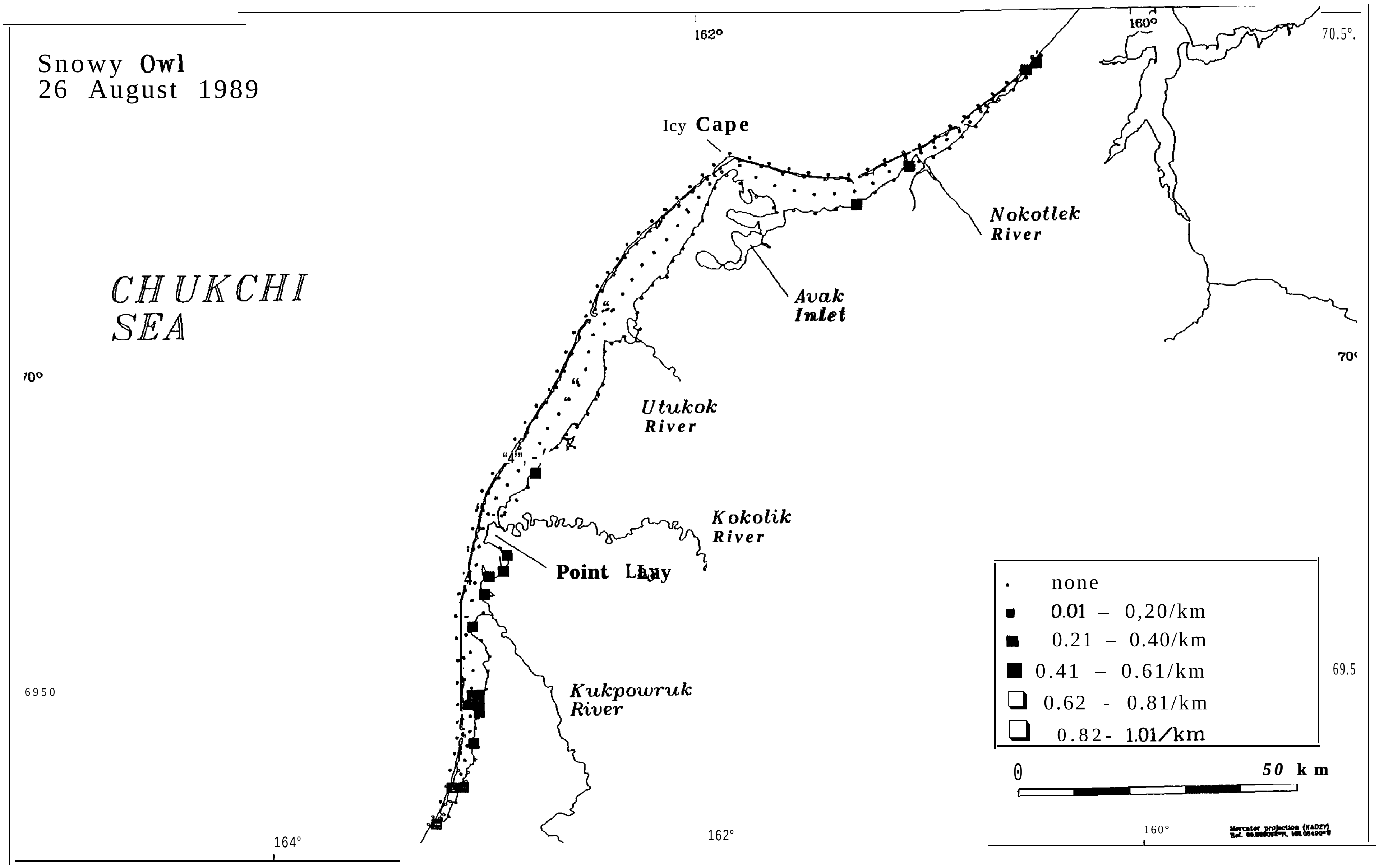

Small Shorebirds
23 August 1990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 478.46/km²
478.47 – 956.91/km²
956.92 – 1435.37/km²
1435.38 – 1913.82/km²
1913.83 – 2392.28/km²
0
50 km
70.5°
70°
69.5°
162°
160°
164°

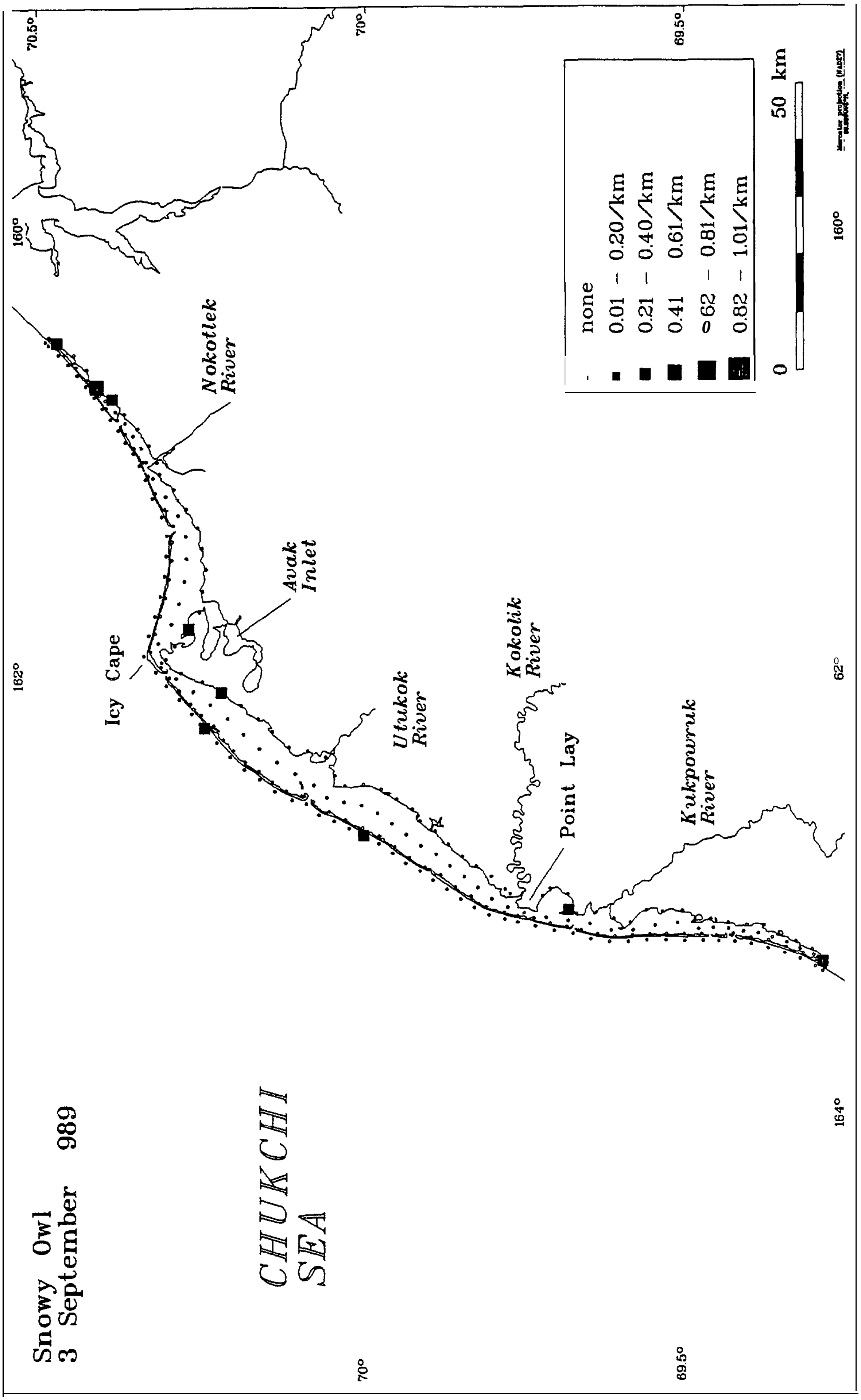
Small Shorebirds
8 September 1990

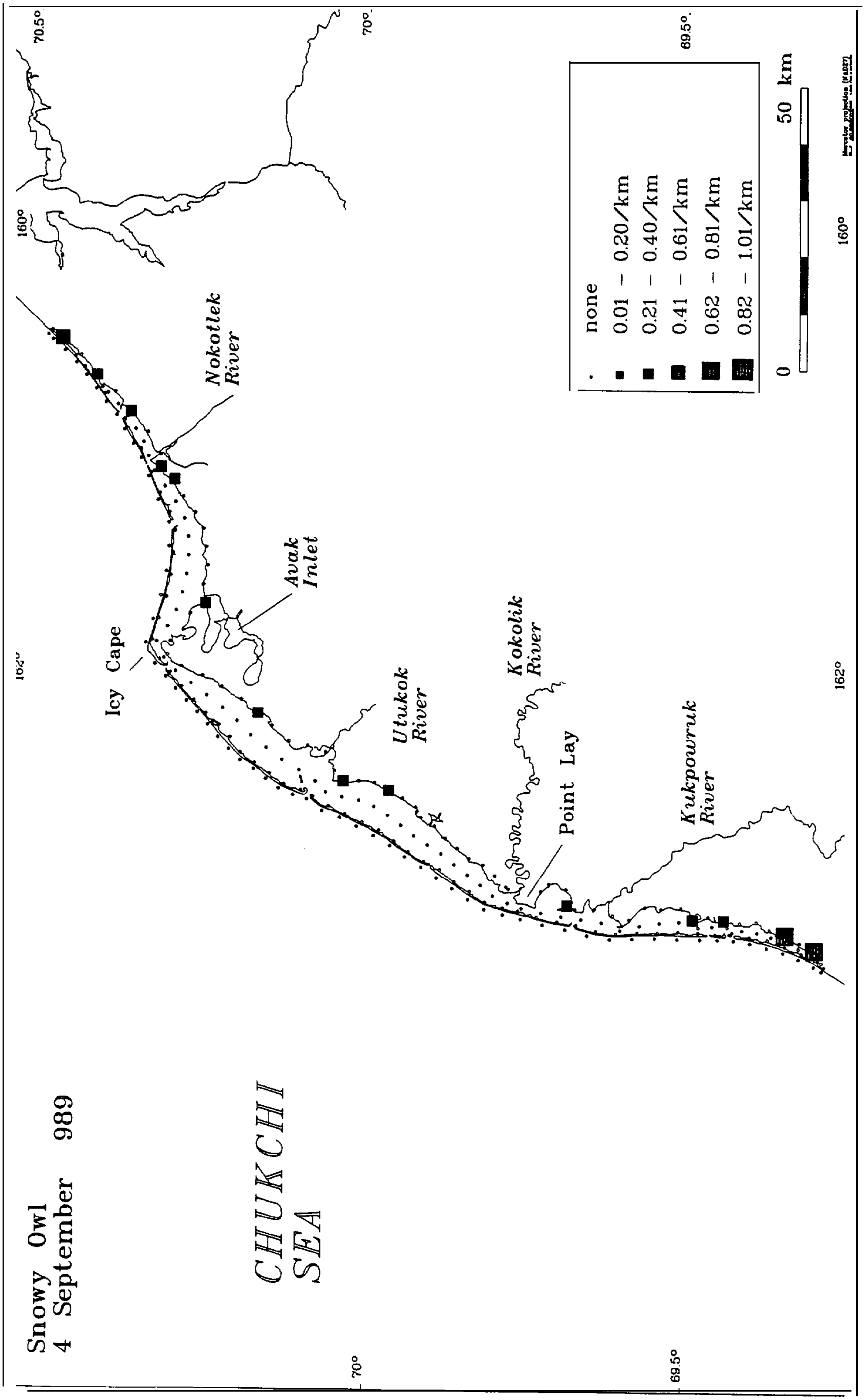


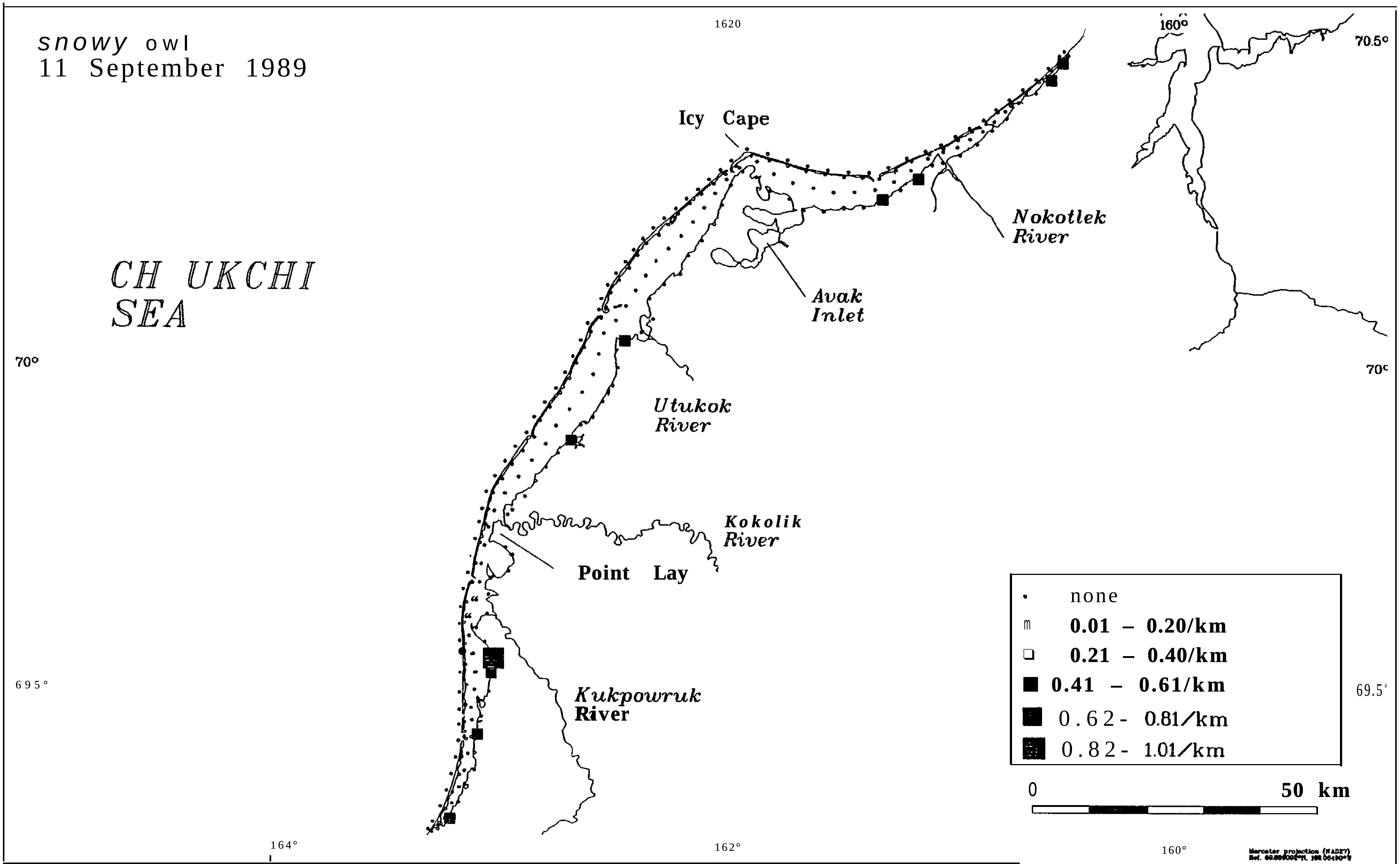

mall Shorebirds
0 September 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 478.46/km²
478.47 – 956.91/km²
956.92 – 435.37/km²
1435.38 1913.82/km²
1913.83 – 2392.28/km²
0
50 km
160°
70°
69.5°
162°
164°

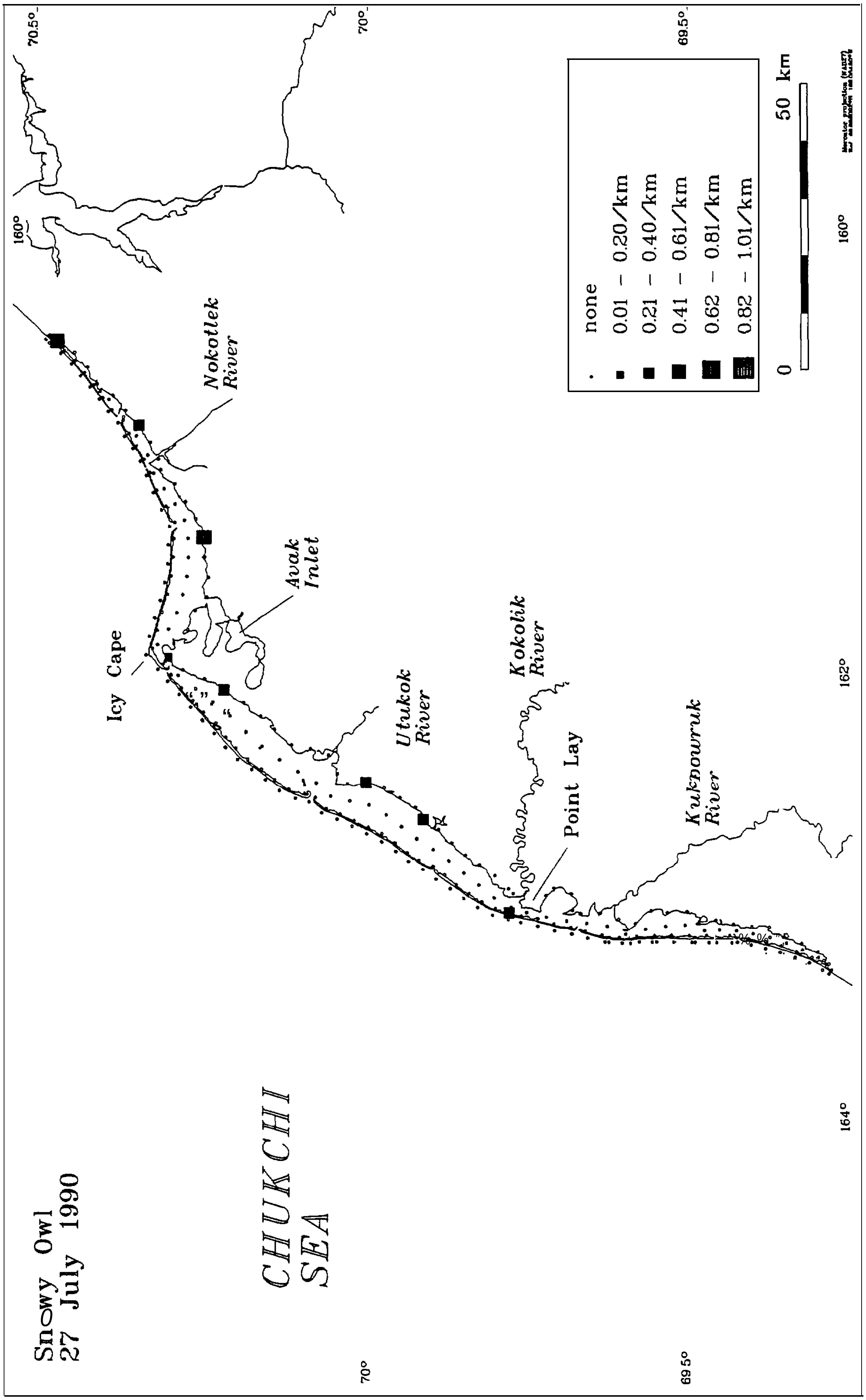

Snowy Owl
24 August 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 – 0.61/km
0.62 – 0.81/km
0.82 – 1.01/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

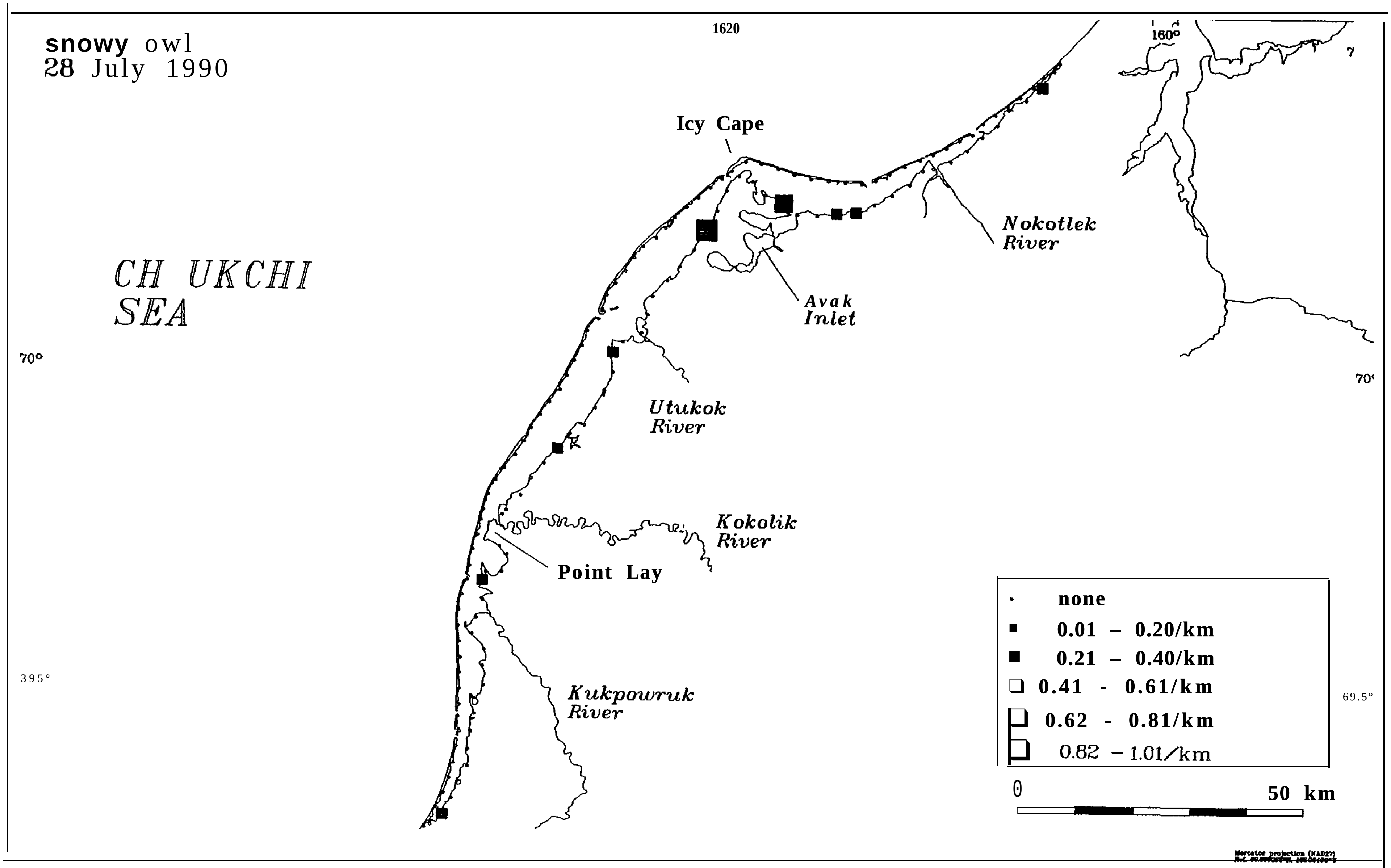

Snowy Owl
26 August 1989
162°
160°
70.5°.
Icy Cape
Nokotlek
River
Avak
Inlet
CHUKCHI
SEA
70°
70°
Utukok
River
Kokolik
River
Point Lay
none
0.01 – 0,20/km
0.21 – 0.40/km
0.41 – 0.61/km
0.62 - 0.81/km
0.82- 1.01/km
69.5
6950
Kukpowruk
River
0
50 km
164°
162°
160°

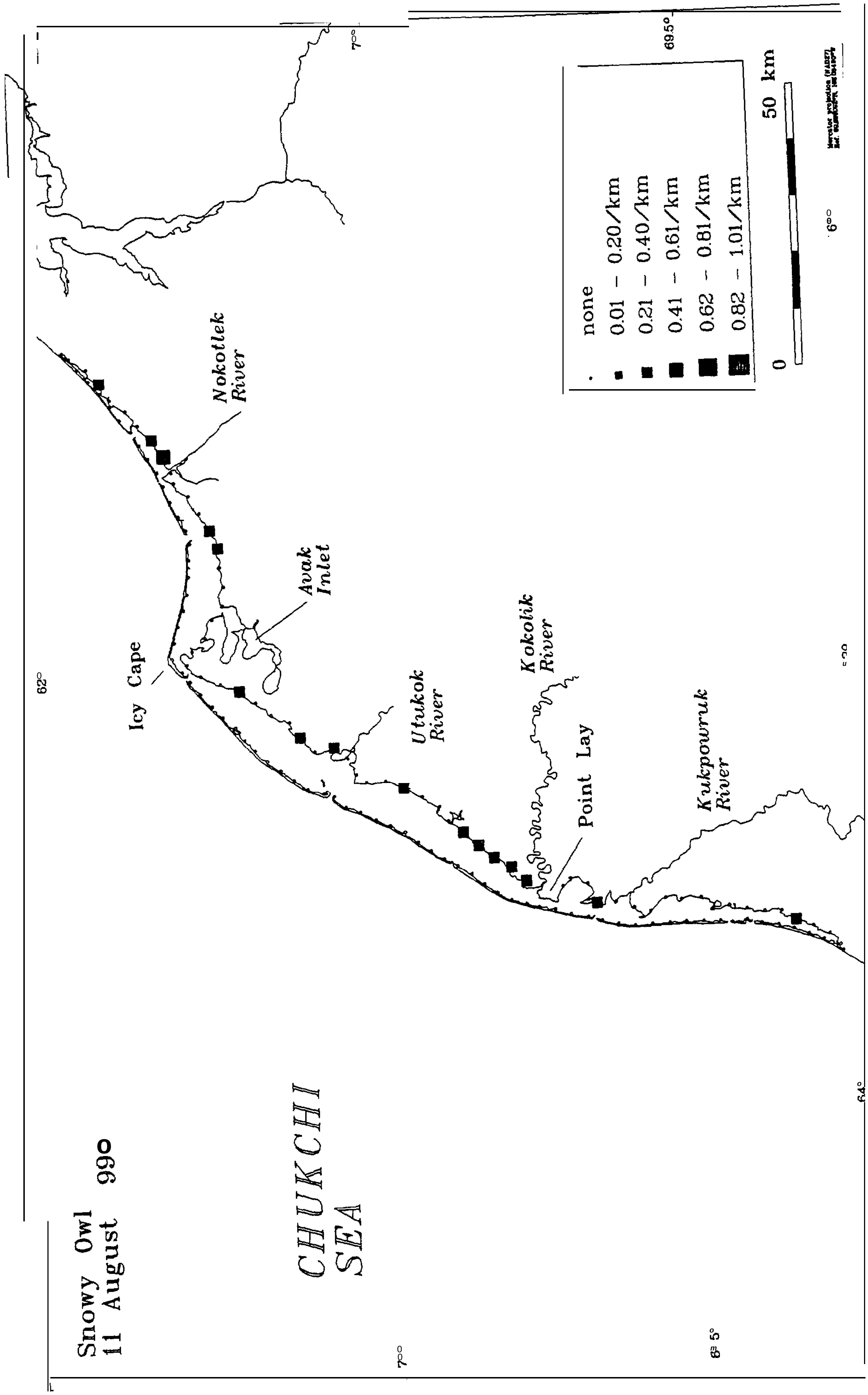

Snowy Owl
3 September 989
CHUKCHI
SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 0.61/km
0.62 – 0.81/km
0.82 – 1.01/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°


Snowy Owl
4 September 989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 – 0.61/km
0.62 – 0.81/km
0.82 – 1.01/km
0
50 km
70.5°
70°
69.5°
160°
162°

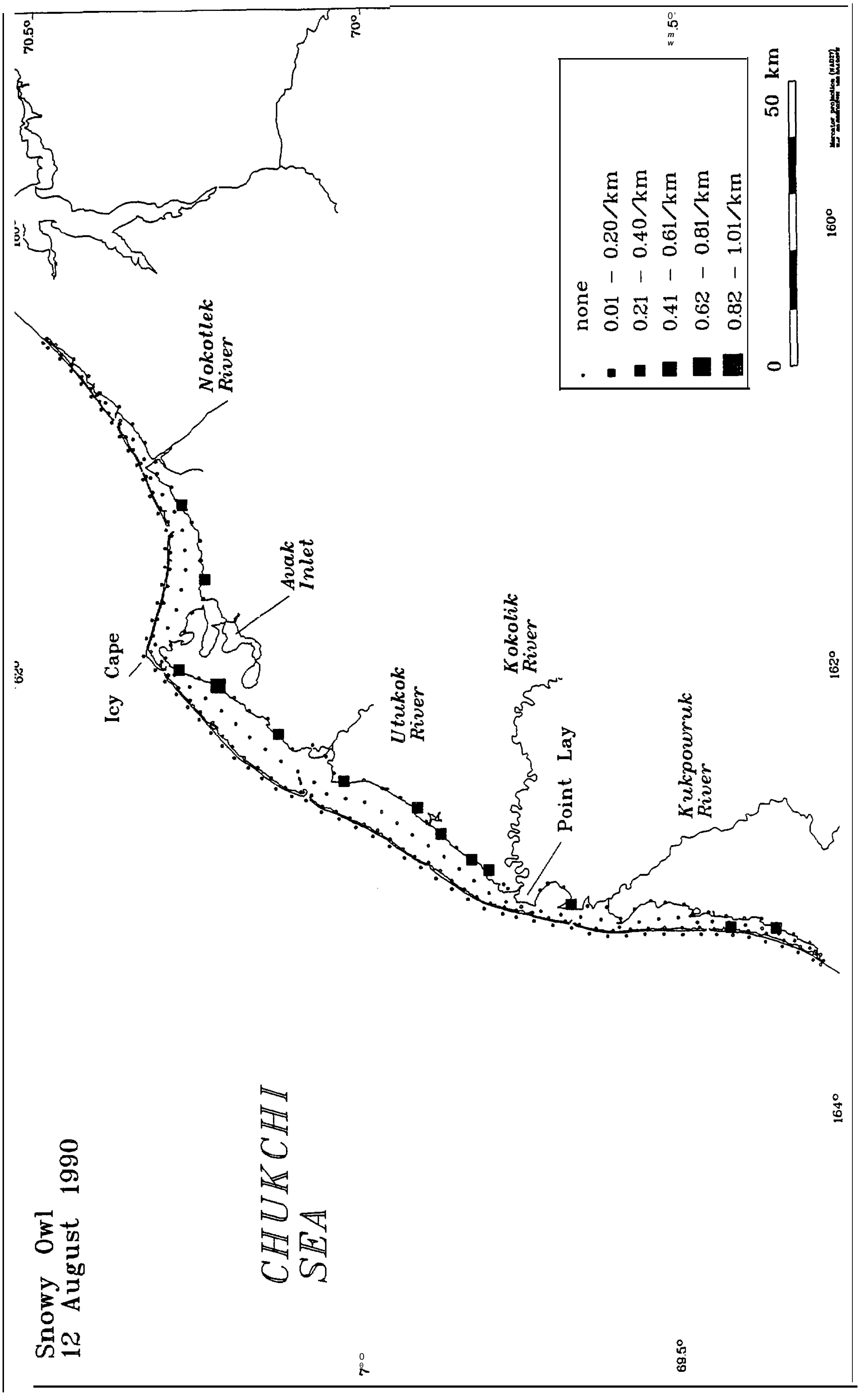

snowy owl
11 September 1989
CH UKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
1620
160°
70.5°
70°
70°
695°
69.5°
164°
162°
160°
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 – 0.61/km
0.62- 0.81/km
0.82- 1.01/km
0
50 km

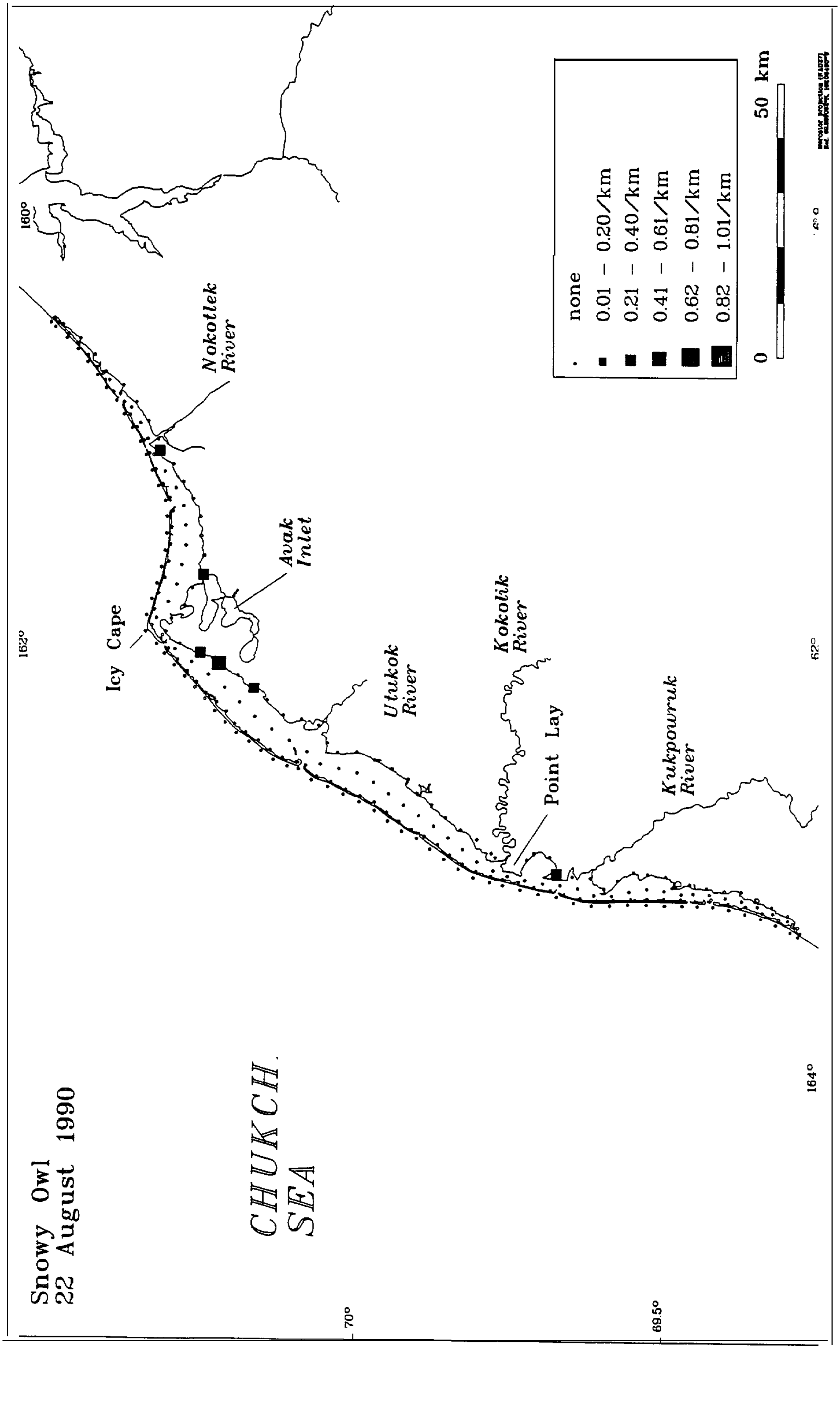

Snowy Owl
27 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 – 0.61/km
0.62 – 0.81/km
0.82 – 1.01/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

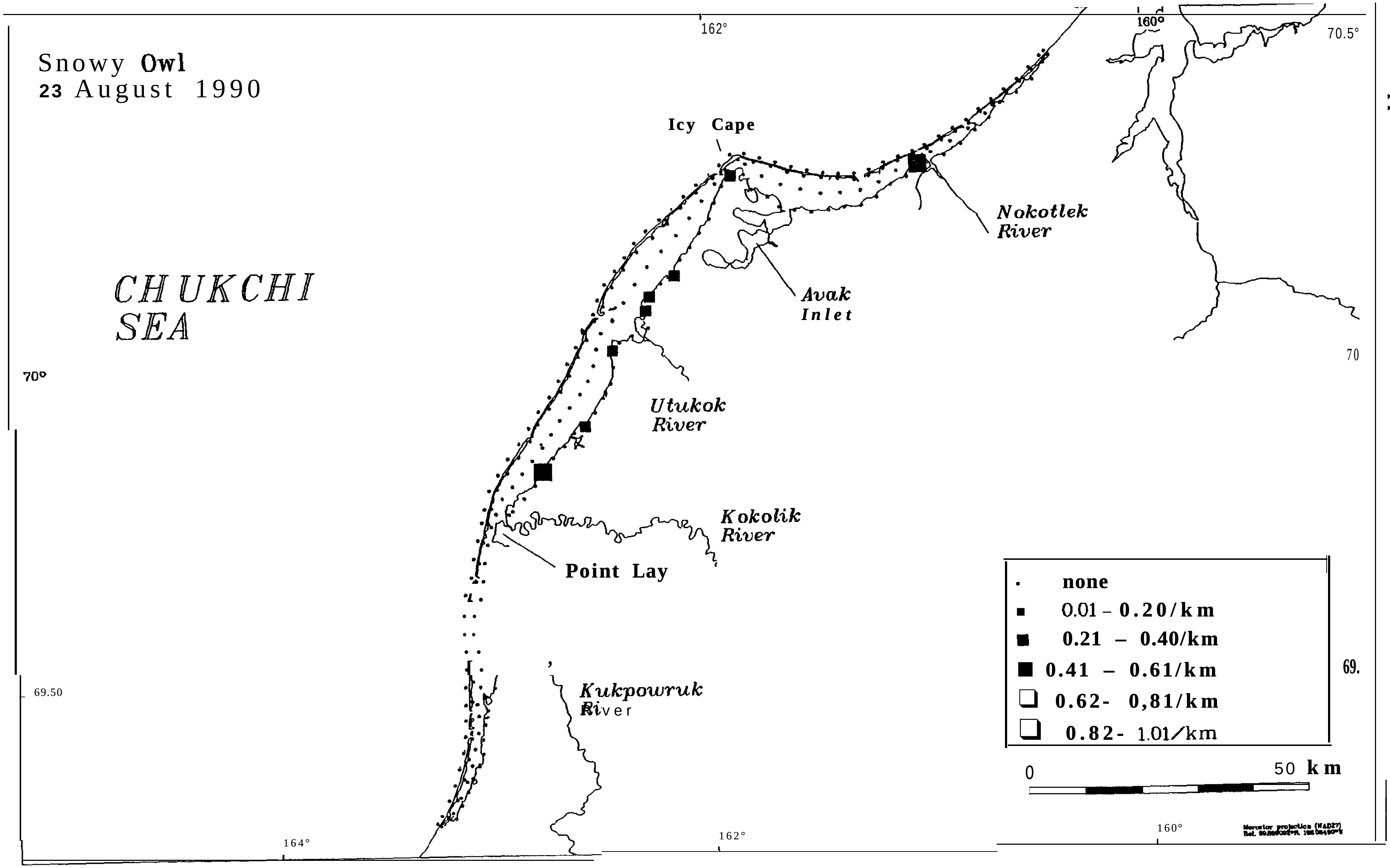

snowy owl
28 July 1990
1620
160°
Icy Cape
CH UKCHI
SEA
Nokotlek
River
Avak
Inlet
70°
70°
Utukok
River
Kokolik
River
Point Lay
395°
69.5°
Kukpowruk
River
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 - 0.61/km
0.62 - 0.81/km
0.82 – 1.01/km
0
50 km
Mercator projection (NAD27)

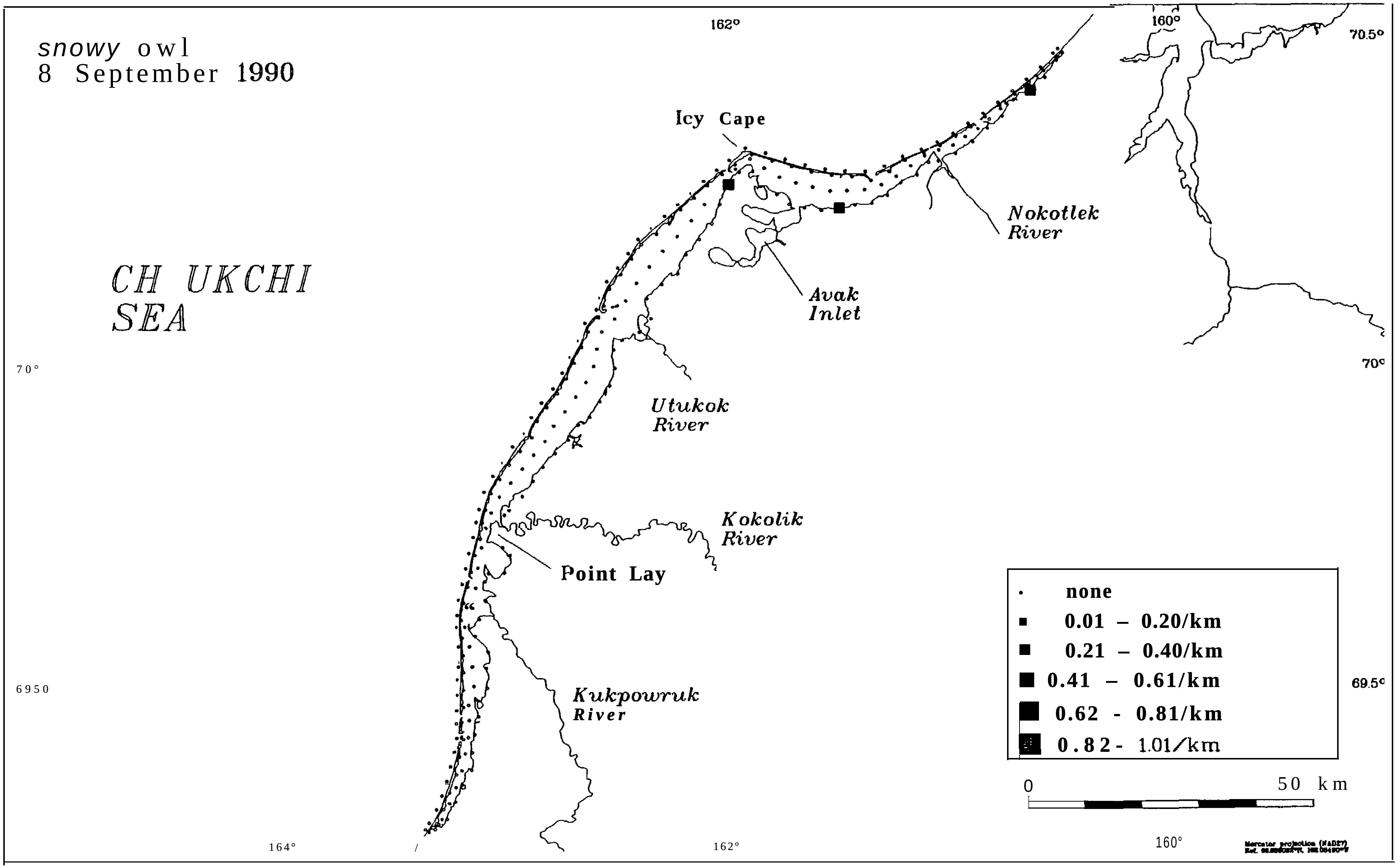


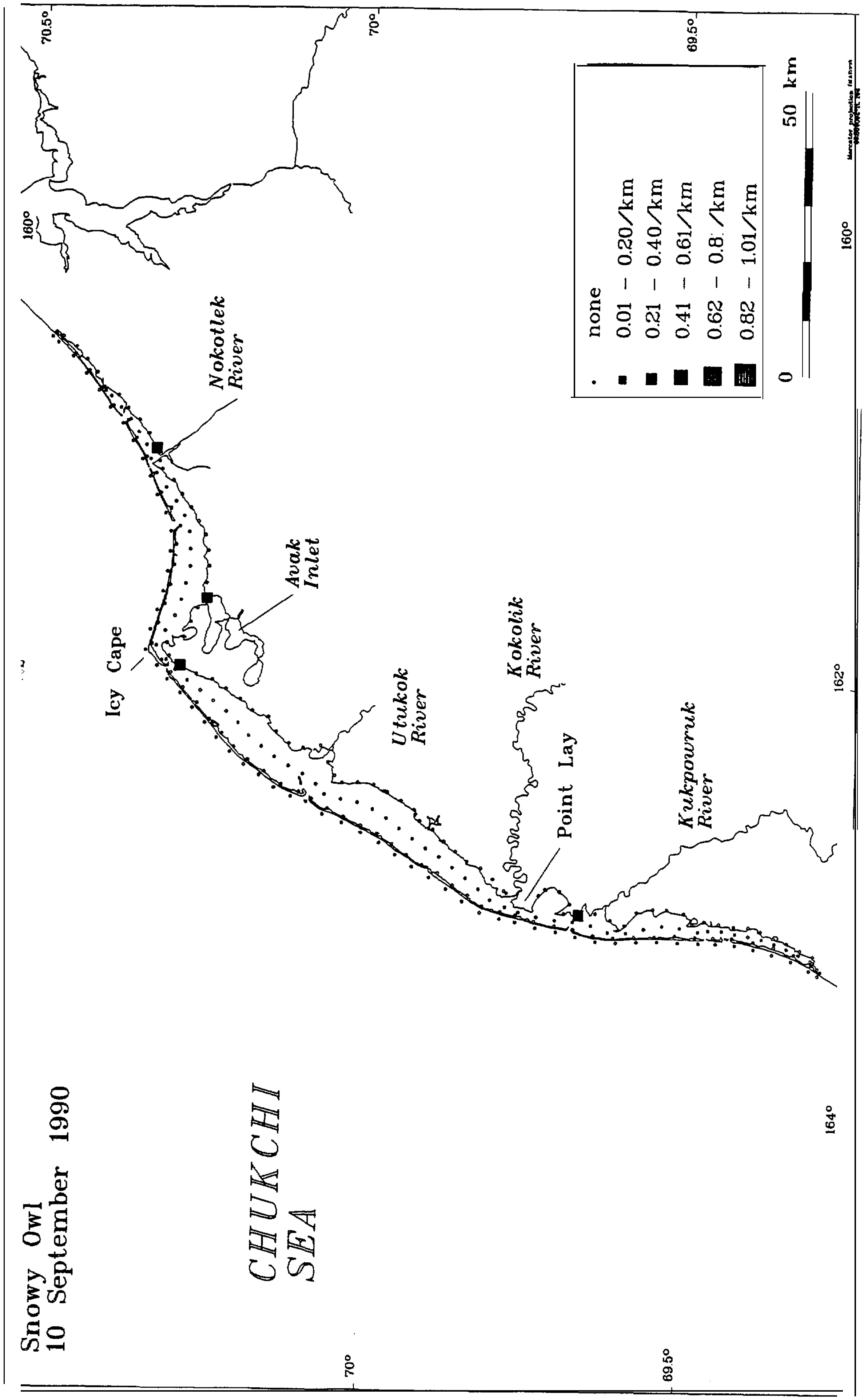
Snowy Owl
11 August 990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 – 0.61/km
0.62 – 0.81/km
0.82 – 1.01/km
0
50 km
69.5°

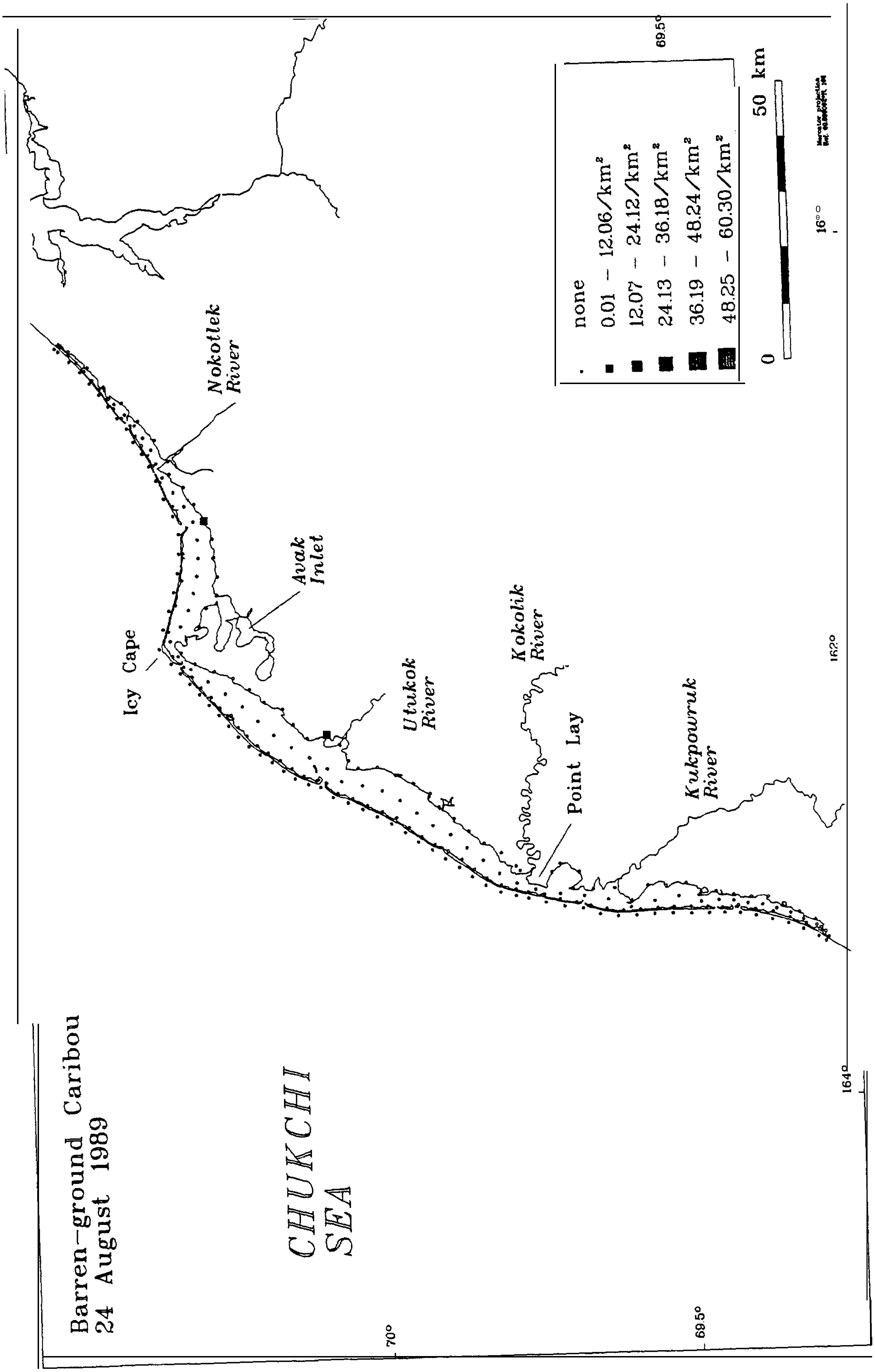

Snowy Owl
12 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 – 0.61/km
0.62 – 0.81/km
0.82 – 1.01/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

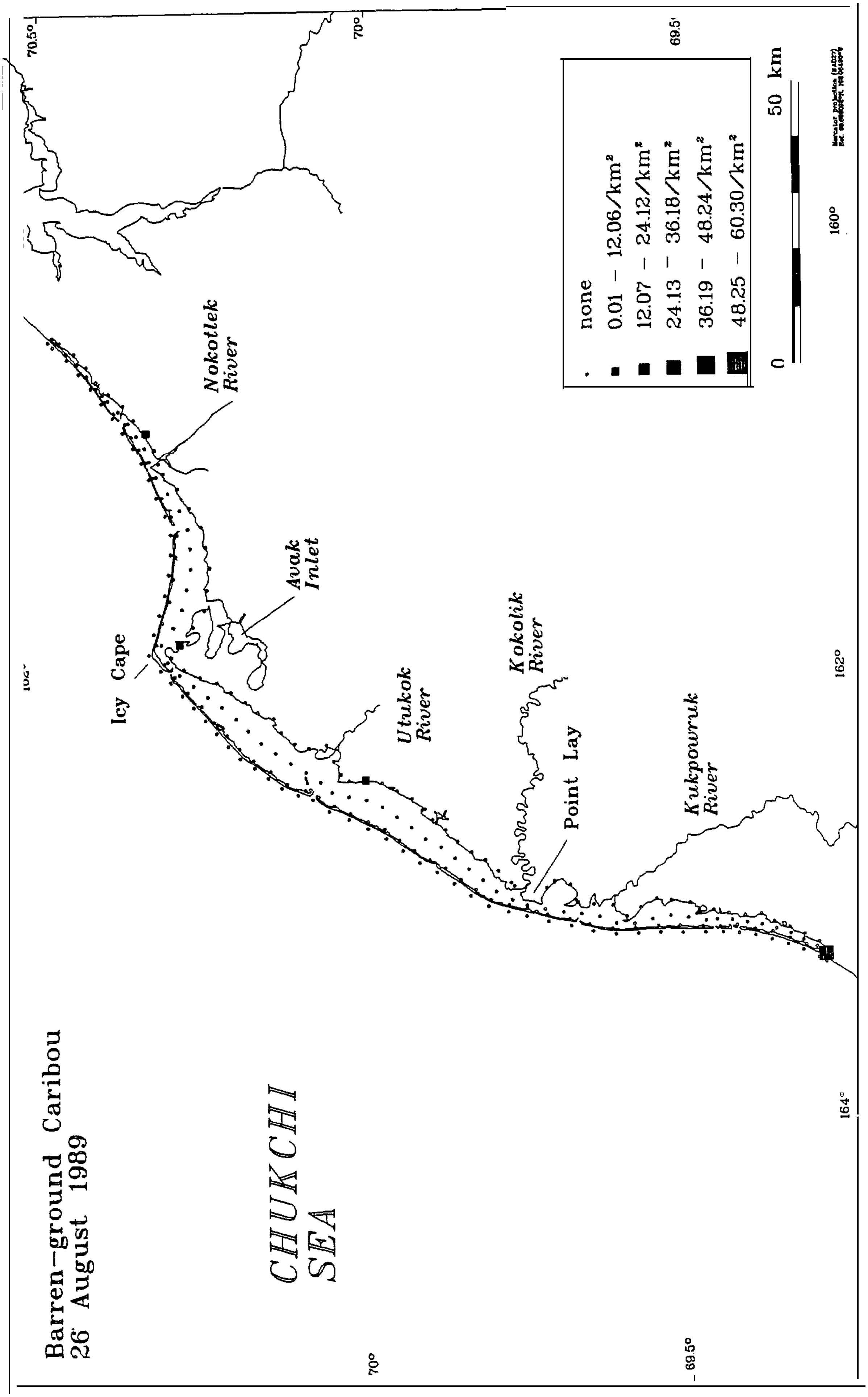

Snowy Owl
22 August 1990
CHUKCH
SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 – 0.61/km
0.62 – 0.81/km
0.82 – 1.01/km
0
50 km
160°
162°
164°
70°
69.5°

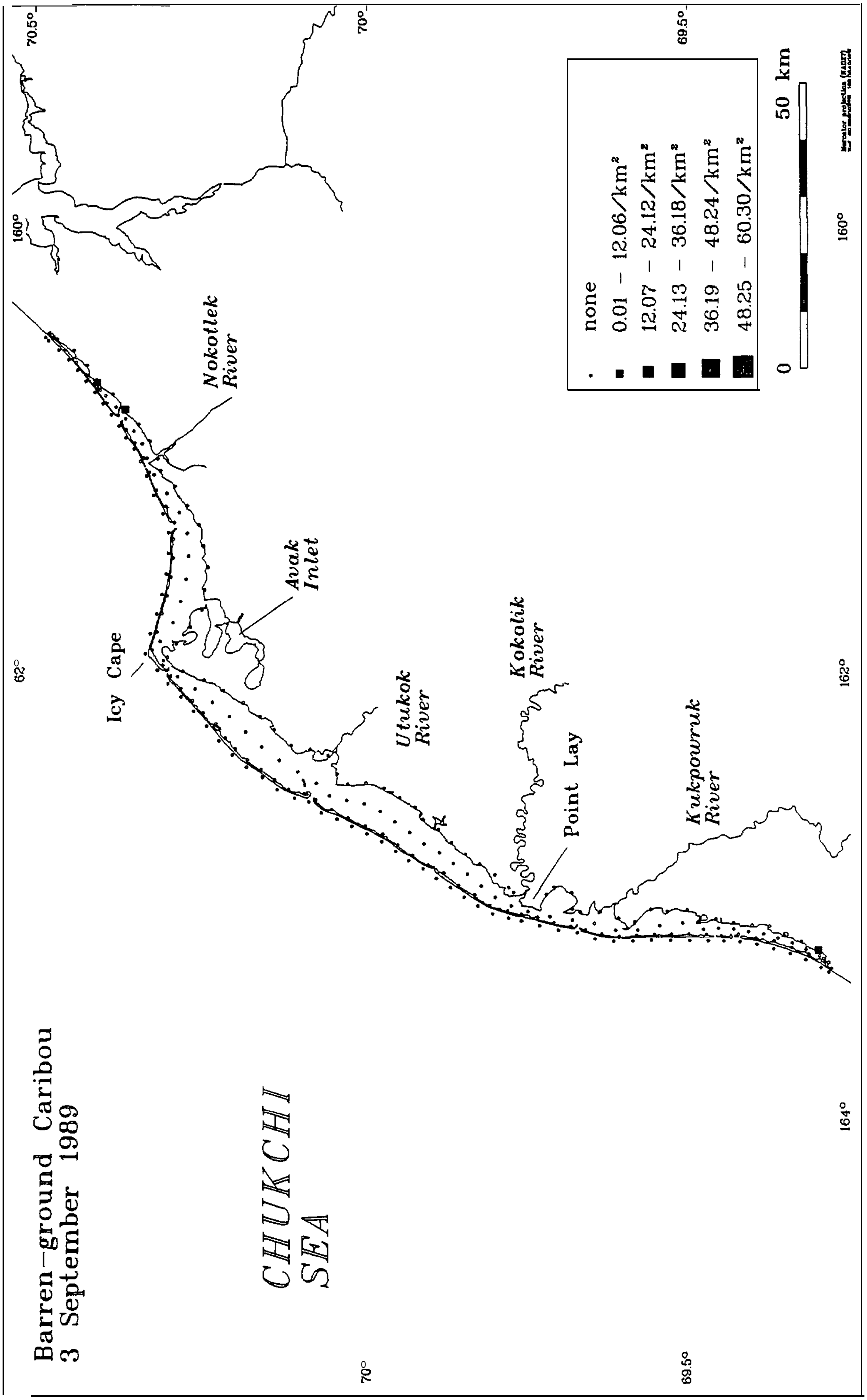

Snowy Owl
23 August 1990
162°
160°
70.5°
Icy Cape
Nokotlek
River
Avak
Inlet
CHUKCHI
SEA
70°
70
Utukok
River
Kokolik
River
Point Lay
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 – 0.61/km
0.62- 0,81/km
0.82- 1.01/km
69.
69.50
Kukpowruk
River
0
50 km
164°
162°
160°

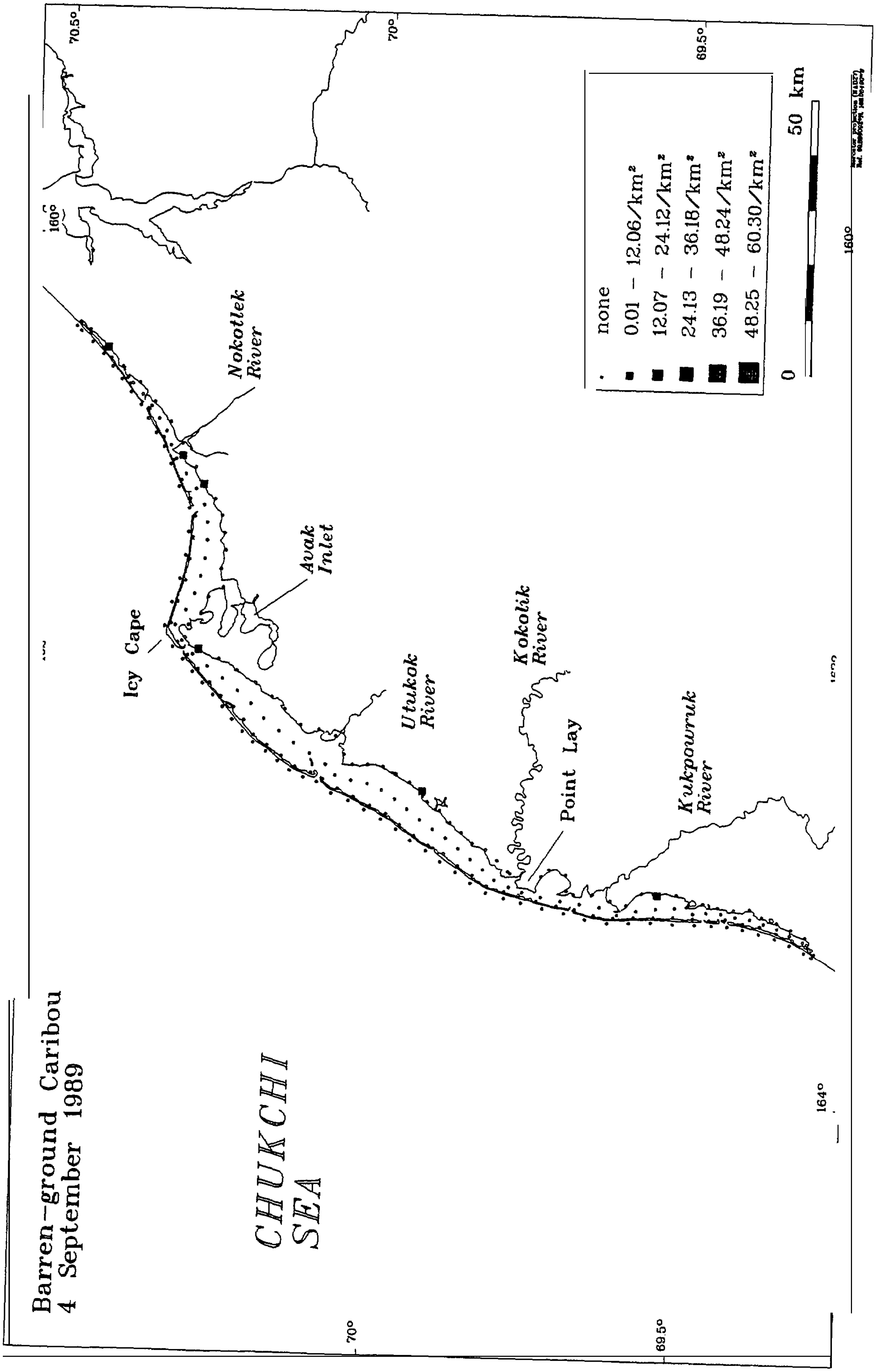

snowy owl
8 September 1990
162°
160°
70.5°
Icy Cape
Nokotlek
River
CH UKCHI
SEA
Avak
Inlet
70°
70°
Utukok
River
Kokolik
River
Point Lay
• none
▪ 0.01 – 0.20/km
■ 0.21 – 0.40/km
■ 0.41 – 0.61/km
■ 0.62 - 0.81/km
■ 0.82 - 1.01/km
0
50 km
6950
69.5°
Kukpowruk
River
164°
162°
160°


Snowy Owl
10 September 1990
CHUKCHI
SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 0.20/km
0.21 – 0.40/km
0.41 – 0.61/km
0.62 – 0.8: /km
0.82 – 1.01/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

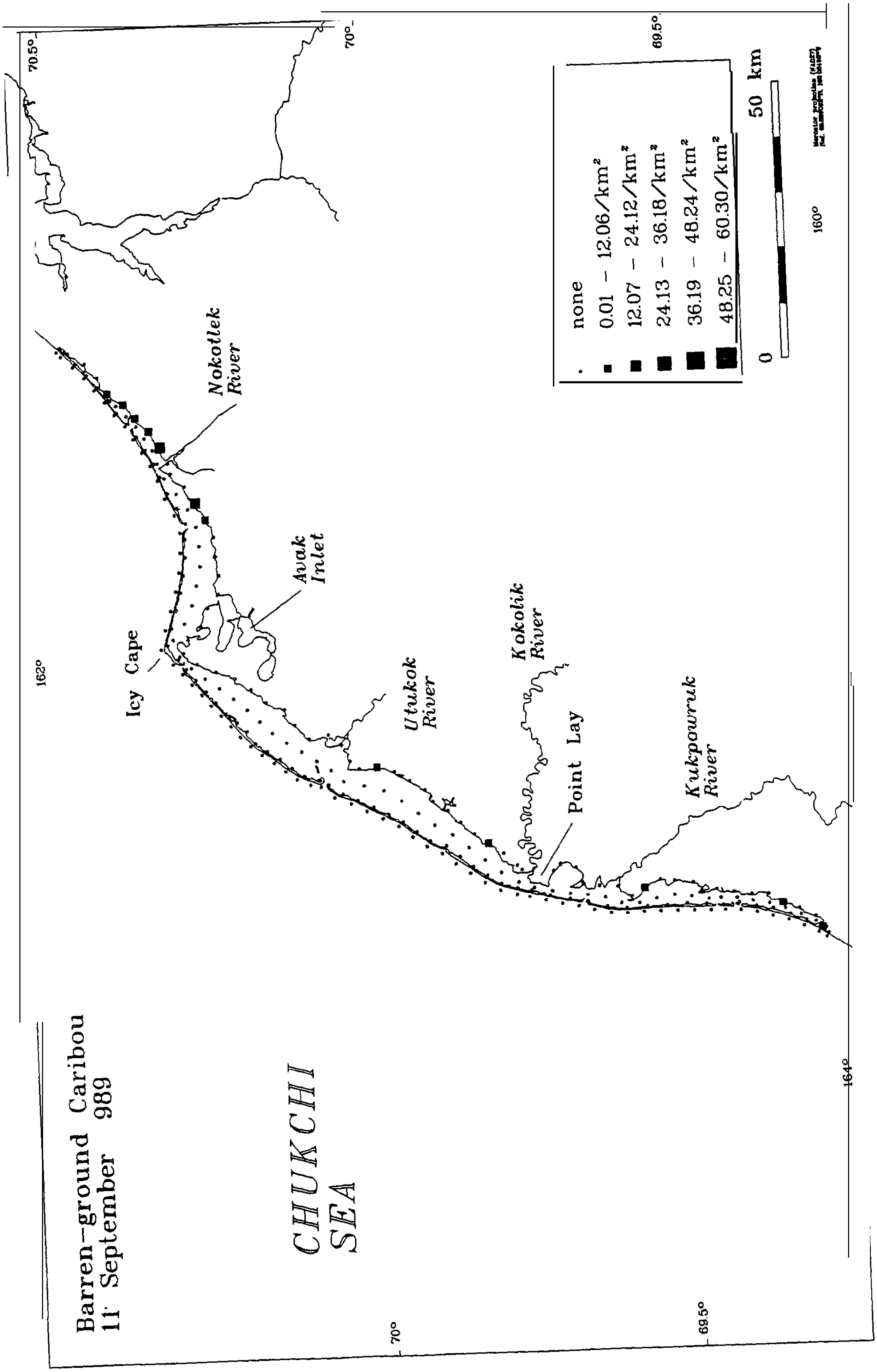

Barren-ground Caribou
24 August 1989
CHUKCHI
SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 12.06/km²
12.07 - 24.12/km²
24.13 - 36.18/km²
36.19 - 48.24/km²
48.25 - 60.30/km²
0
50 km
70°
69.5°
164°
162°
160°
69.5°

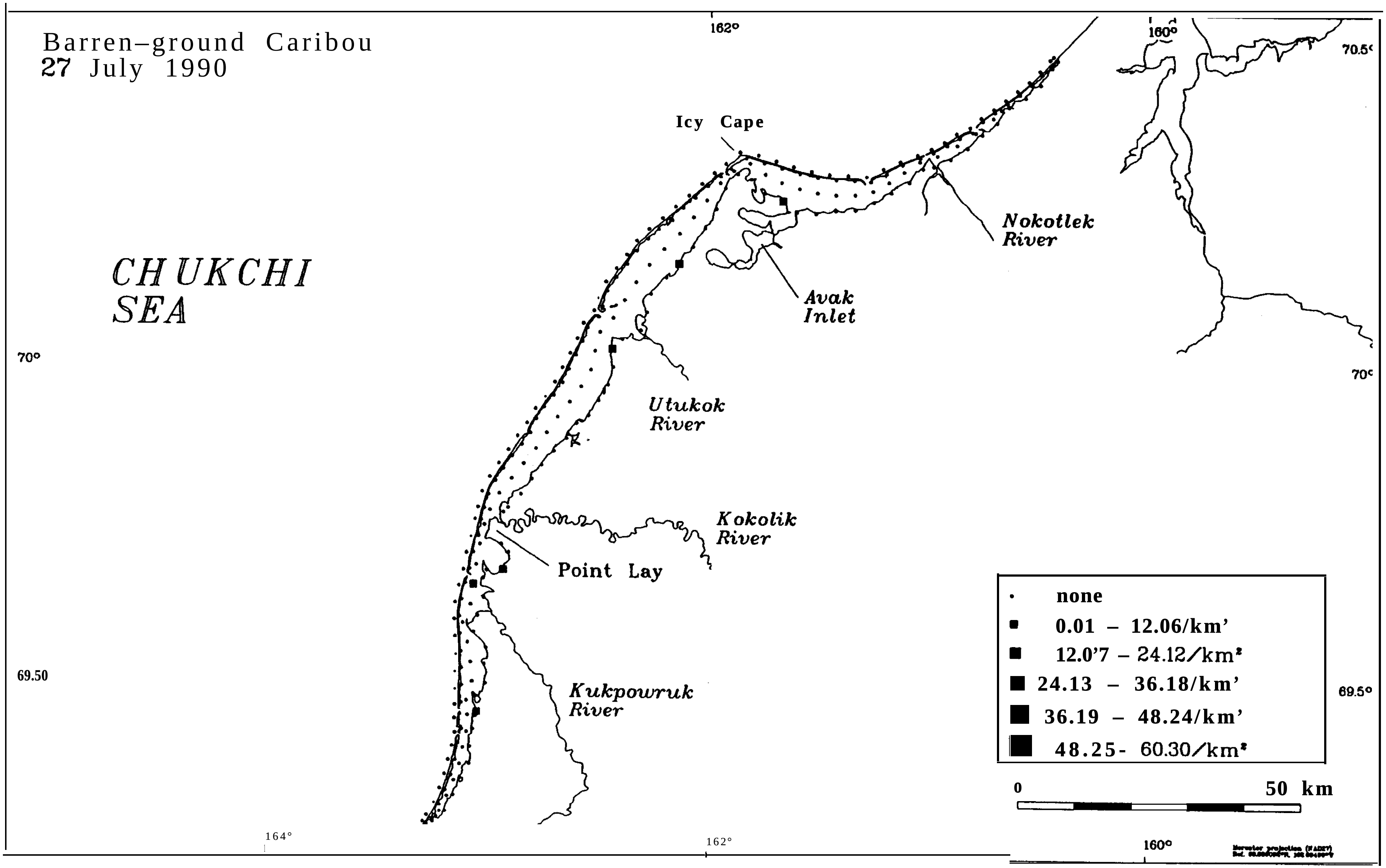

Barren-ground Caribou
26 August 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 12.06/km²
12.07 – 24.12/km²
24.13 – 36.18/km²
36.19 – 48.24/km²
48.25 – 60.30/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

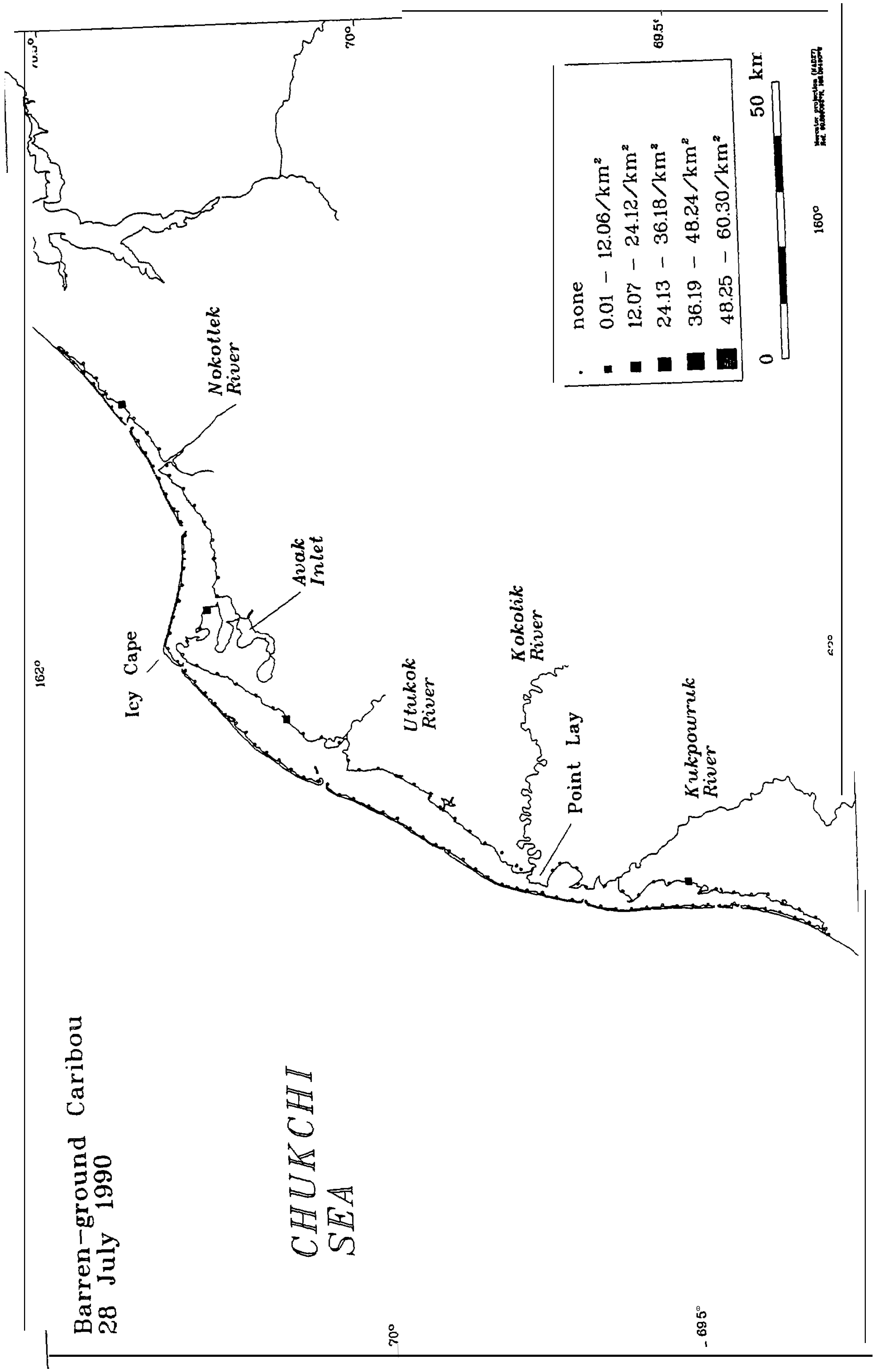

Barren-ground Caribou
3 September 1989
CHUKCHI
SEA
Icy Cape
Avak Inlet
Nokotlek River
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 12.06/km²
12.07 – 24.12/km²
24.13 – 36.18/km²
36.19 – 48.24/km²
48.25 – 60.30/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

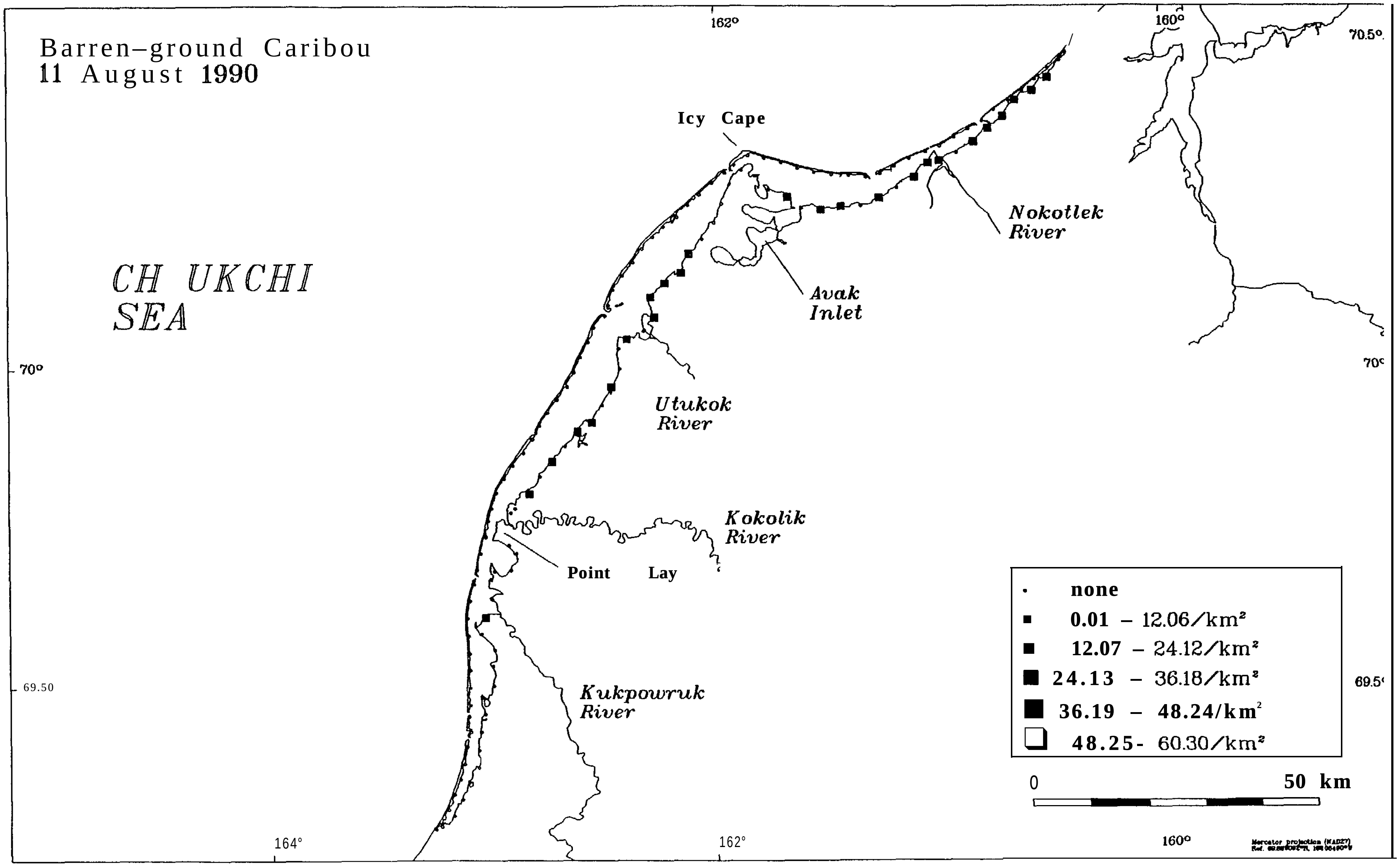


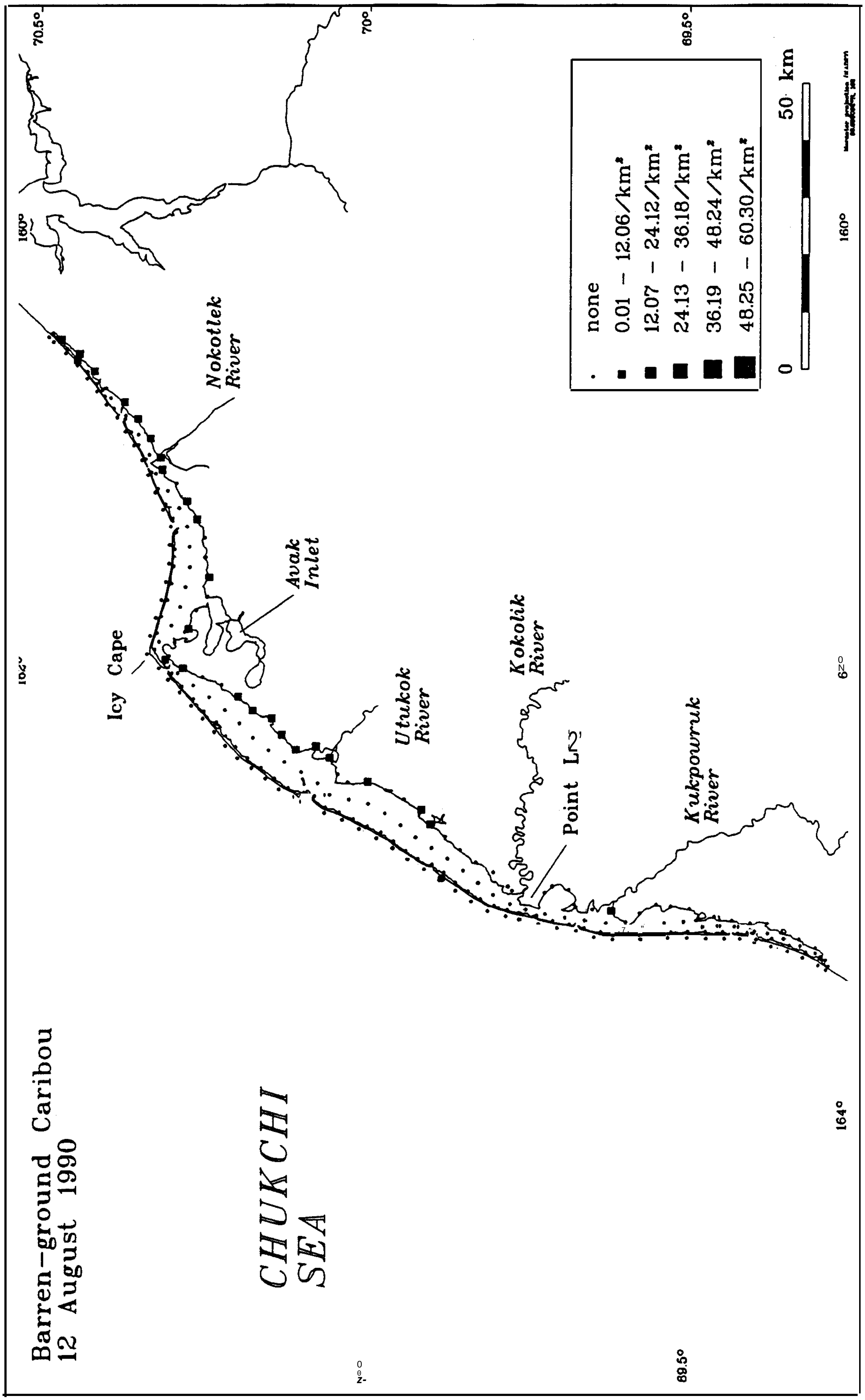
Barren-ground Caribou
4 September 1989
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 12.06/km²
12.07 - 24.12/km²
24.13 - 36.18/km²
36.19 - 48.24/km²
48.25 - 60.30/km²
0
50 km
70.5°
70°
69.5°
160°
164°


Barren-ground Caribou
11 September 989
CHUKCHI
SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 - 12.06/km^2
12.07 - 24.12/km^2
24.13 - 36.18/km^2
36.19 - 48.24/km^2
48.25 - 60.30/km^2
0
50 km
70.5°
70°
69.5°
162°
160°
164°

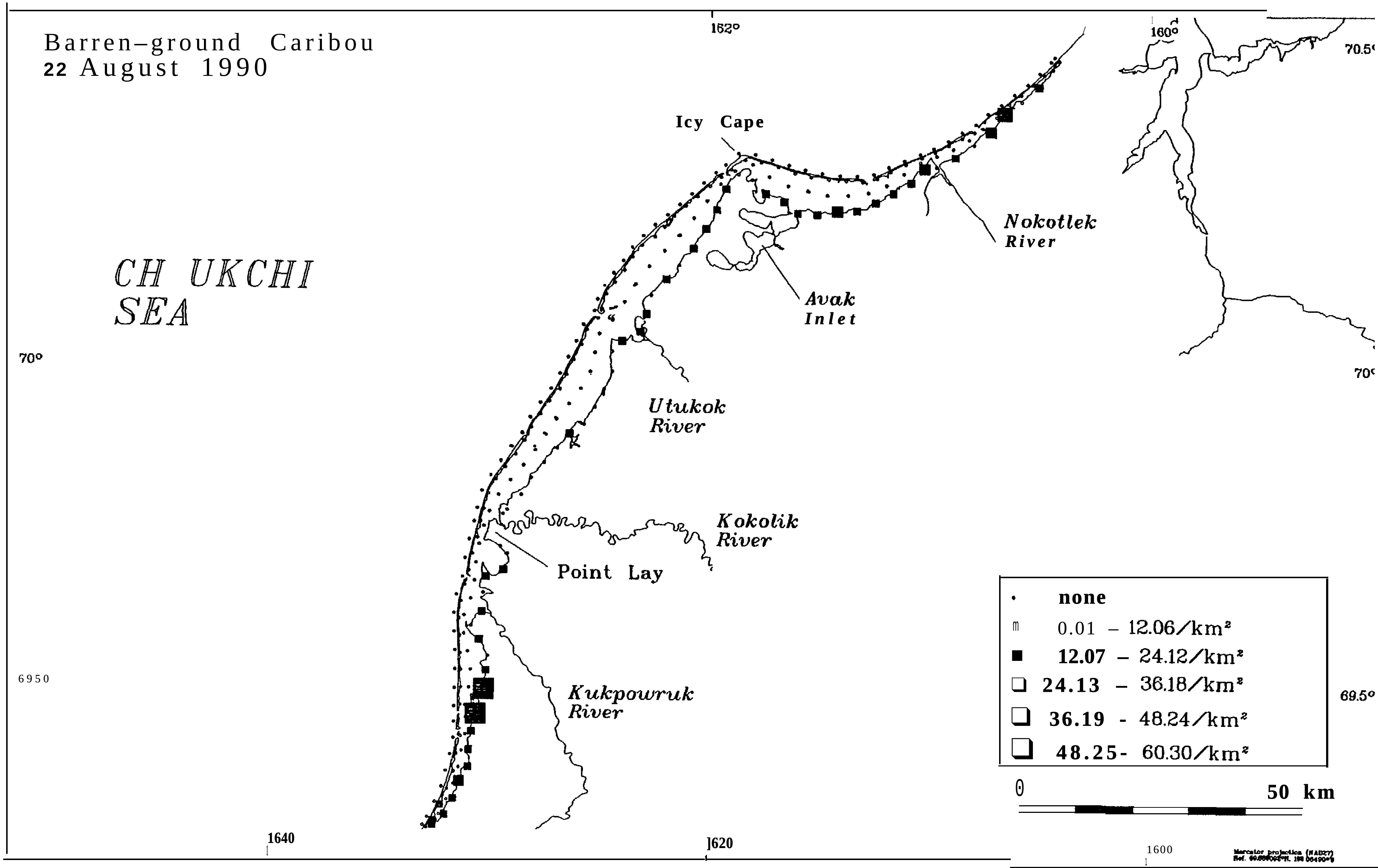

Barren–ground Caribou
27 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
160°
70.5°
70°
70°
69.50
69.5°
164°
162°
160°
none
0.01 – 12.06/km'
12.0'7 – 24.12/km²
24.13 – 36.18/km'
36.19 – 48.24/km'
48.25- 60.30/km²
0
50 km


Barren-ground Caribou
28 July 1990
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 12.06/km²
12.07 – 24.12/km²
24.13 – 36.18/km²
36.19 – 48.24/km²
48.25 – 60.30/km²
0
50 km
70°
69.5°
162°
160°

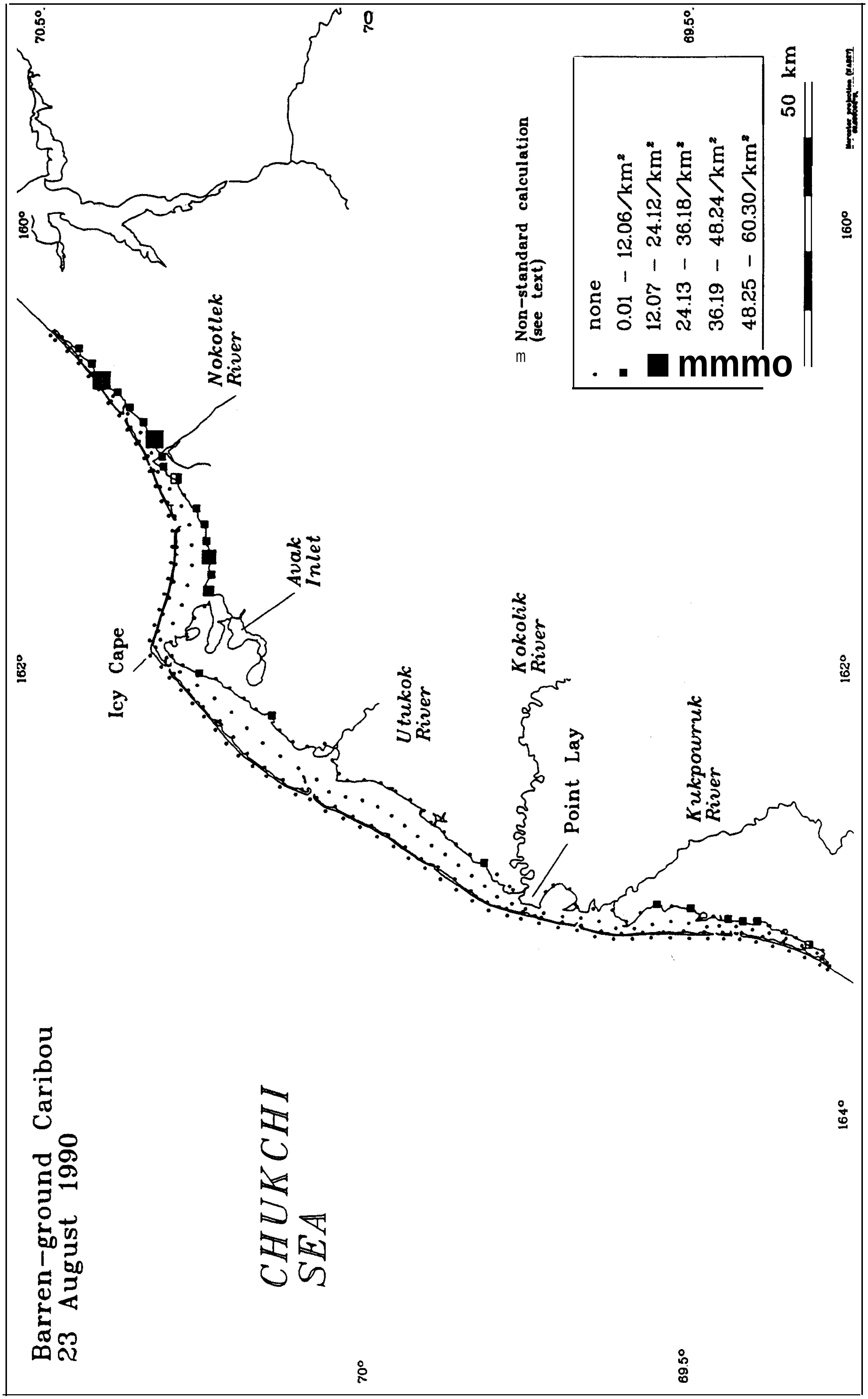

Barren–ground Caribou
11 August 1990
Icy Cape
CH UKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 12.06/km²
12.07 – 24.12/km²
24.13 – 36.18/km²
36.19 – 48.24/km²
48.25- 60.30/km²
0
50 km
162°
160°
70.5°
70°
69.50
69.5°
164°

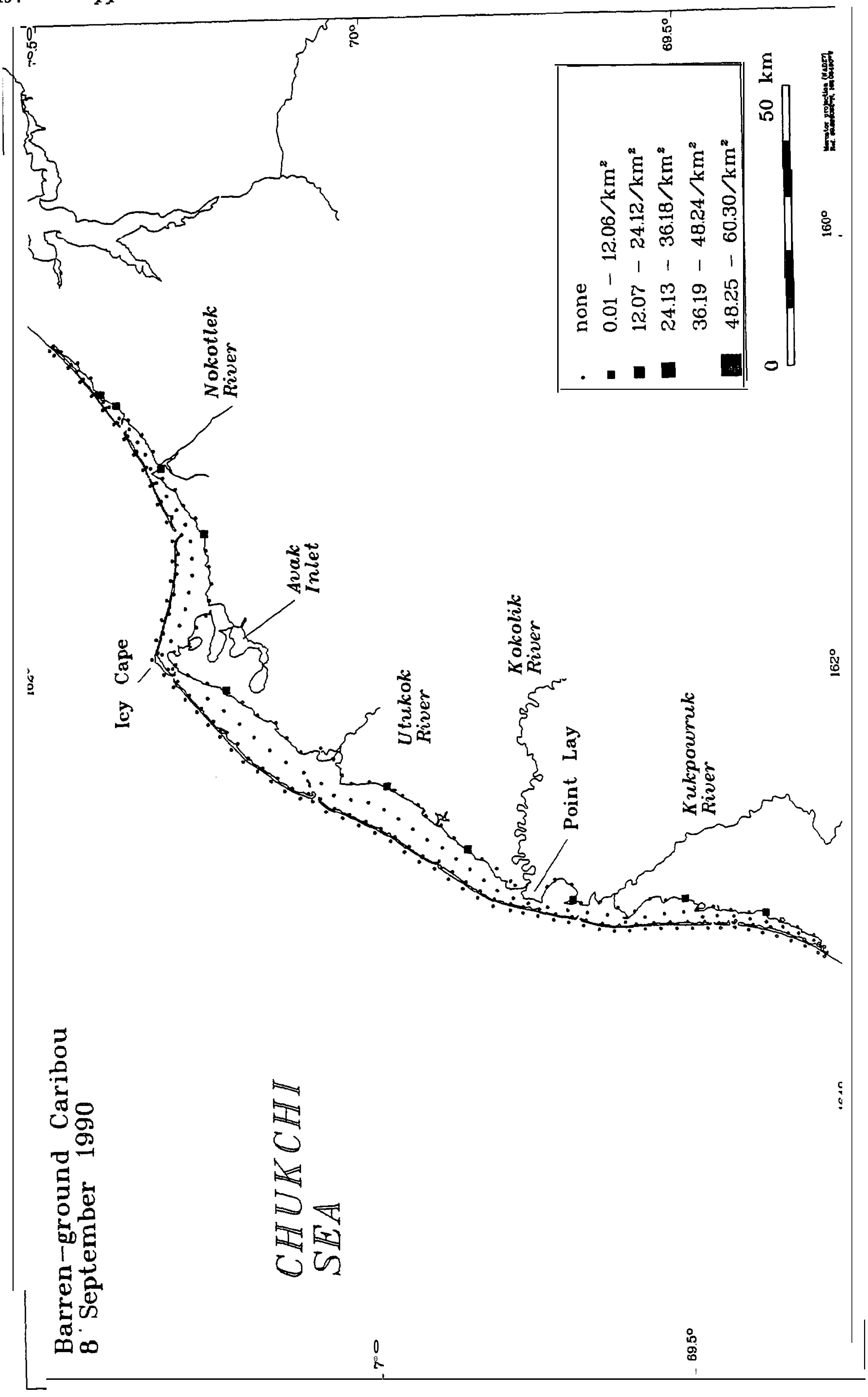


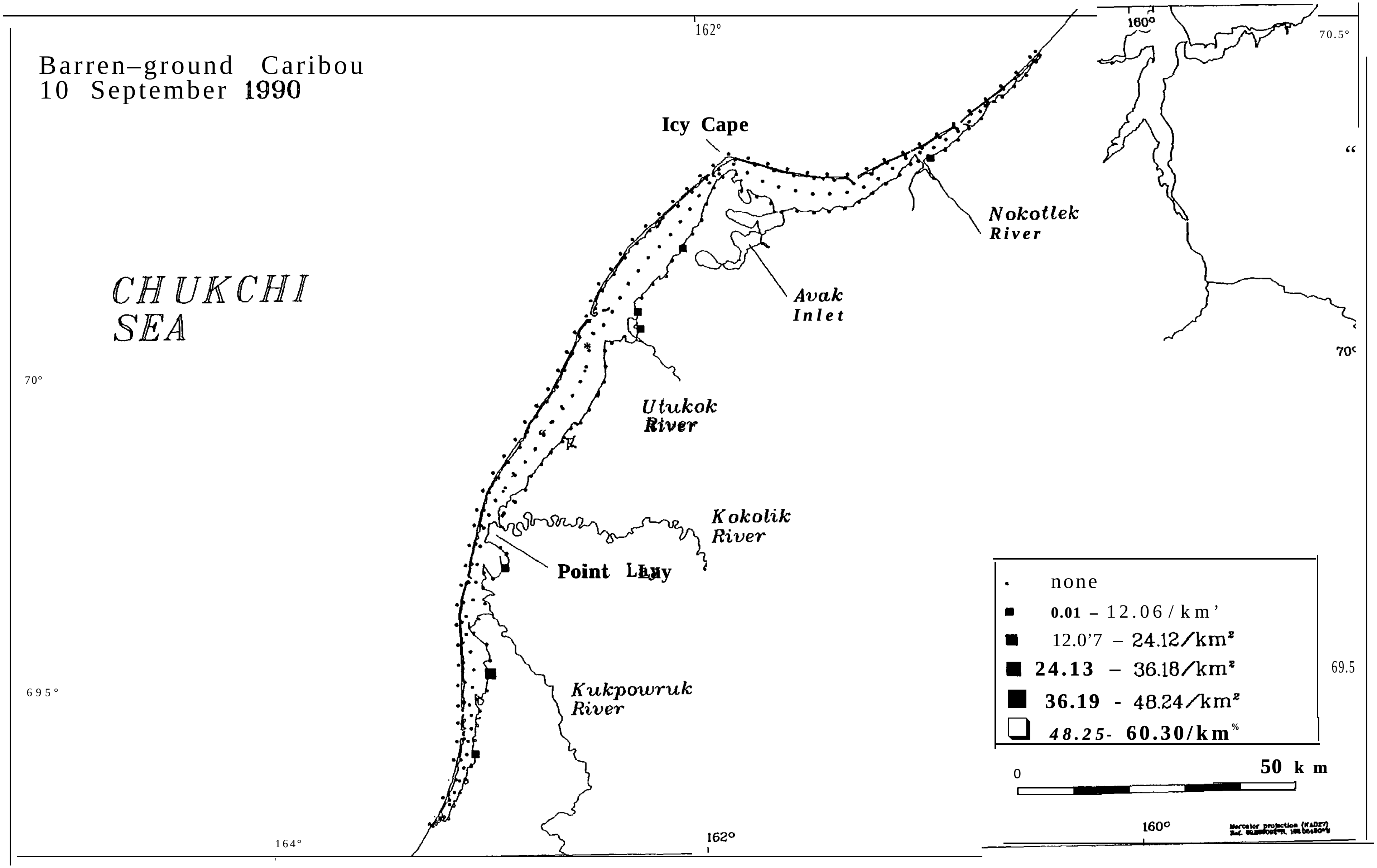
Barren-ground Caribou
12 August 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 12.06/km²
12.07 – 24.12/km²
24.13 – 36.18/km²
36.19 – 48.24/km²
48.25 – 60.30/km²
0
50 km
70.5°
70°
69.5°
160°
164°

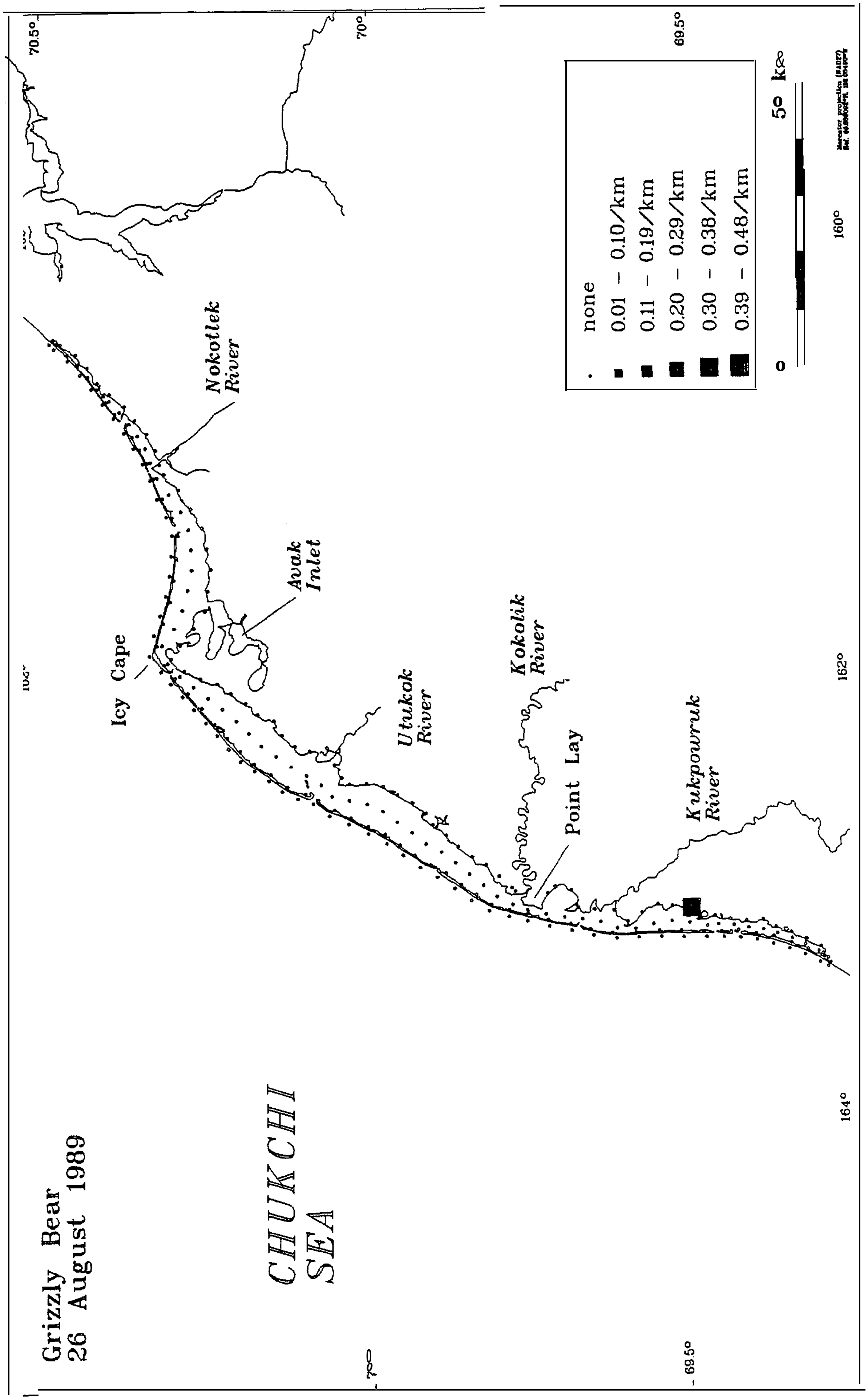


Barren–ground Caribou
22 August 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
70°
6950
69.5°
1640
]620
1600
none
0.01 – 12.06/km²
12.07 – 24.12/km²
24.13 – 36.18/km²
36.19 - 48.24/km²
48.25- 60.30/km²
0
50 km

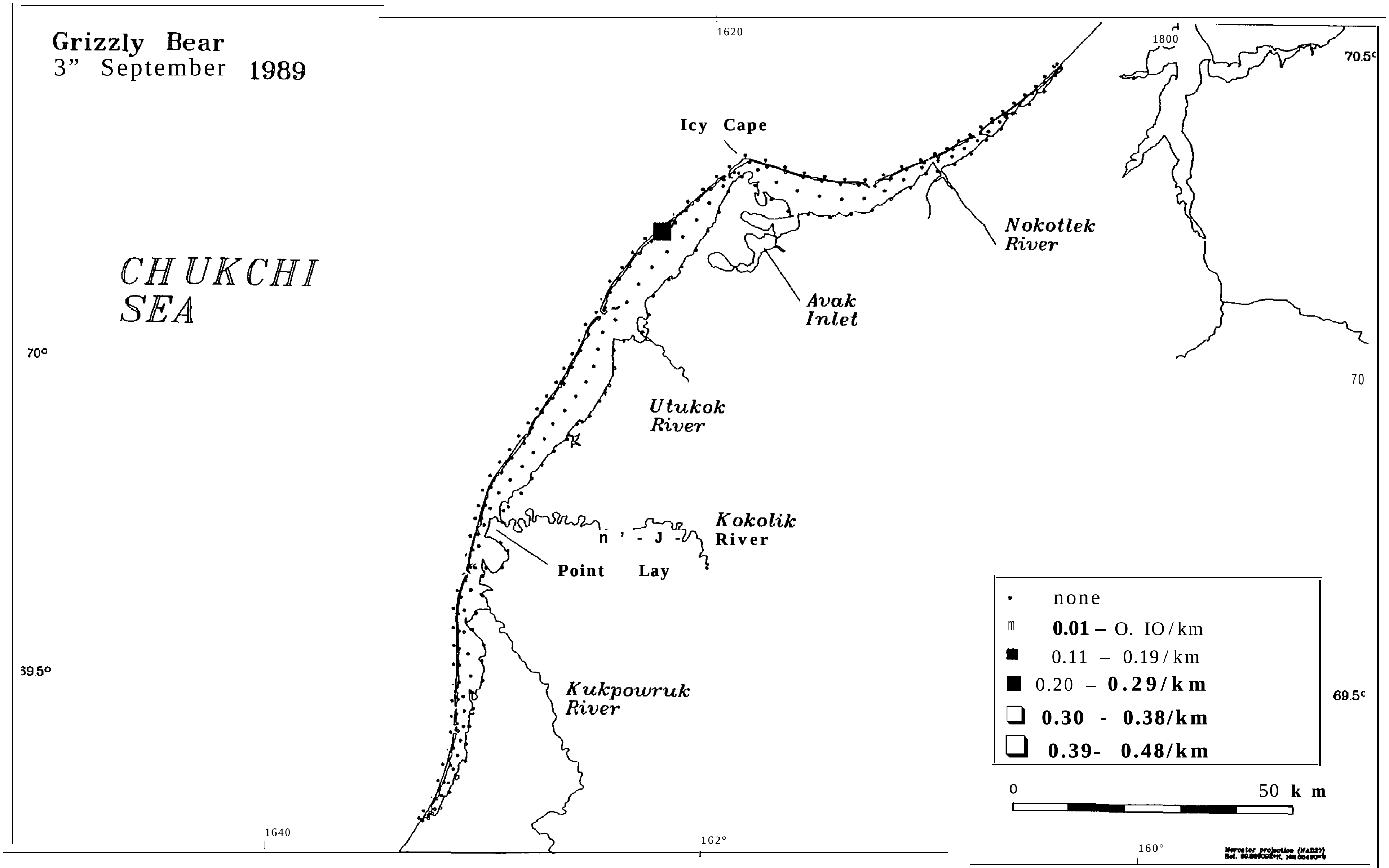

Barren-ground Caribou
23 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
Non-standard calculation
(see text)
none
0.01 – 12.06/km²
12.07 – 24.12/km²
24.13 – 36.18/km²
36.19 – 48.24/km²
48.25 – 60.30/km²
50 km
70.5°
70°
69.5°
160°
162°
164°

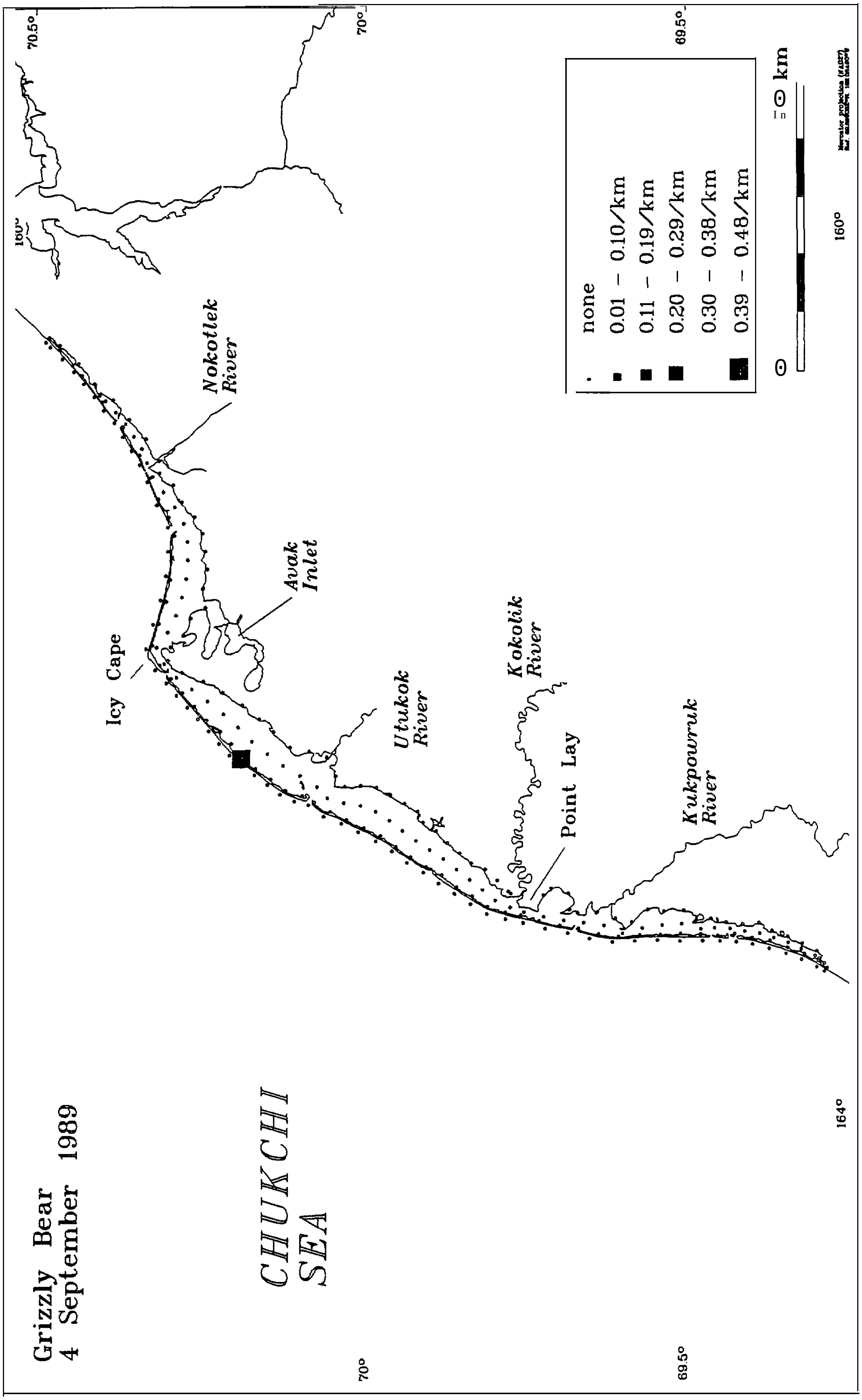

Barren-ground Caribou
8 September 1990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Kokolik River
Utukok River
Point Lay
Kukpowruk River
none
0.01 – 12.06/km²
12.07 – 24.12/km²
24.13 – 36.18/km²
36.19 – 48.24/km²
48.25 – 60.30/km²
0
50 km
70°
69.5°
162°
160°


Barren–ground Caribou
10 September 1990
Icy Cape
CHUKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
164°
70.5°
70°
69.5
695°
none
0.01 – 12.06/km'
12.0'7 – 24.12/km²
24.13 – 36.18/km²
36.19 - 48.24/km²
48.25- 60.30/km²
0
50 km

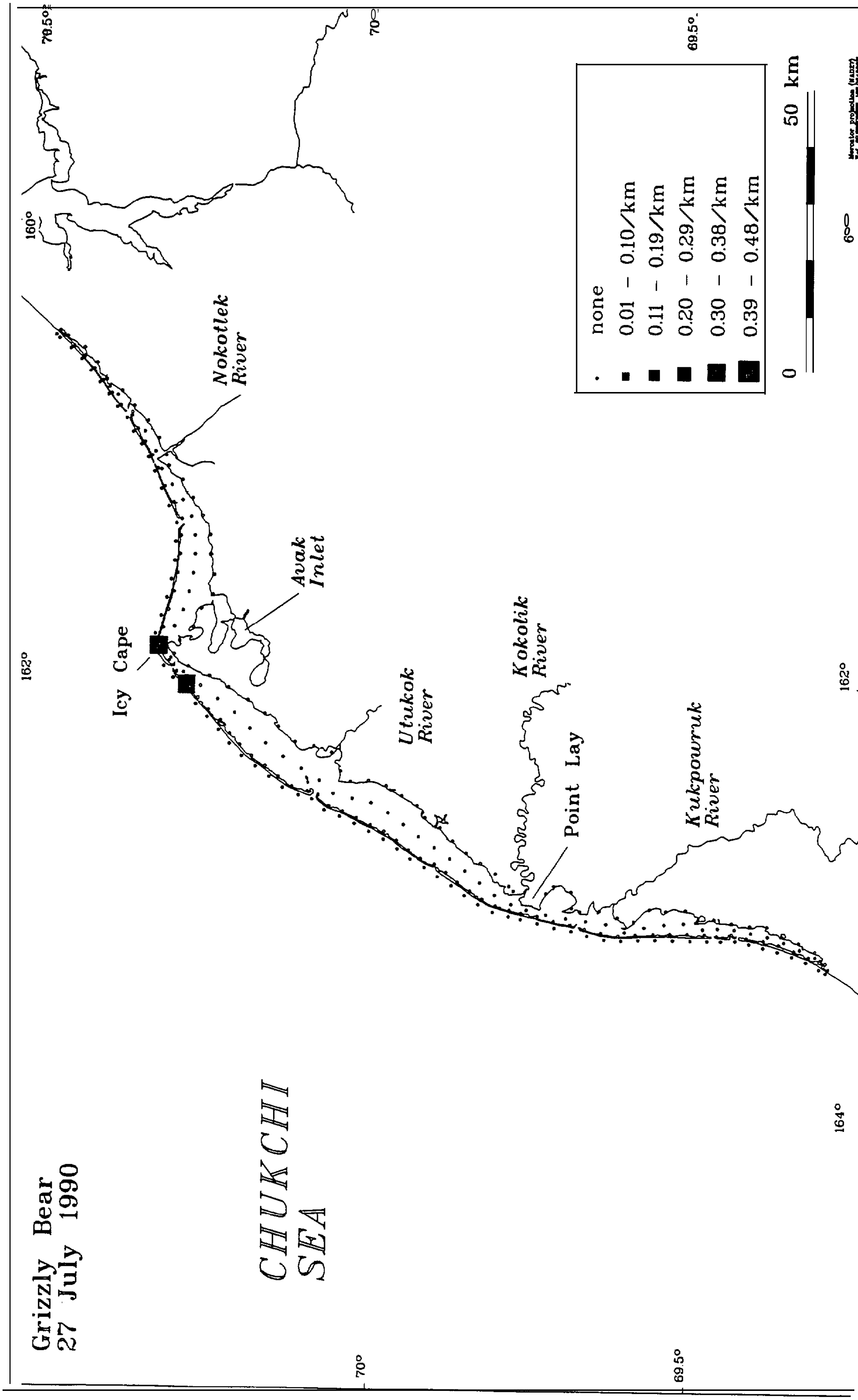


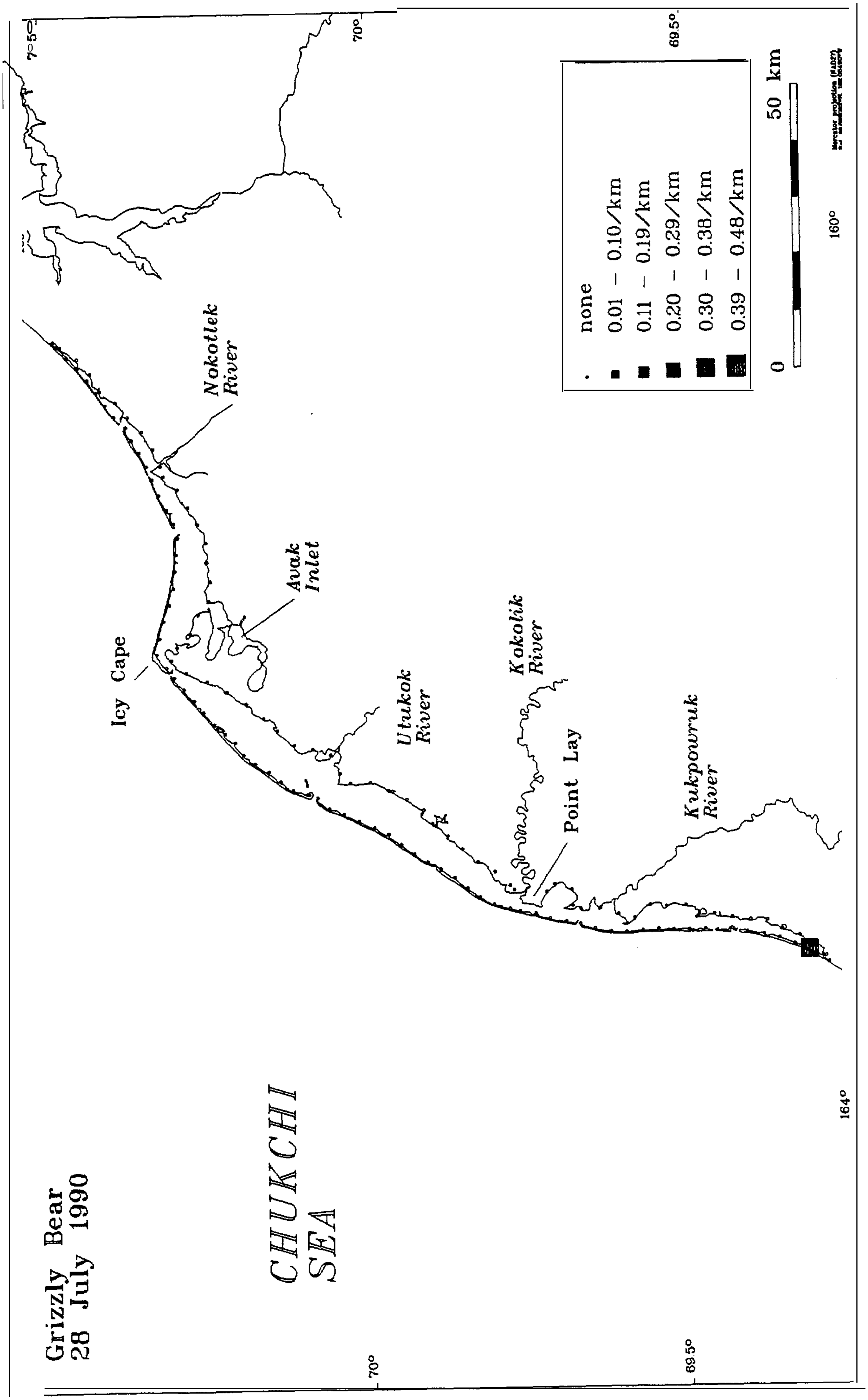
Grizzly Bear
26 August 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 0.10/km
0.11 - 0.19/km
0.20 - 0.29/km
0.30 - 0.38/km
0.39 - 0.48/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

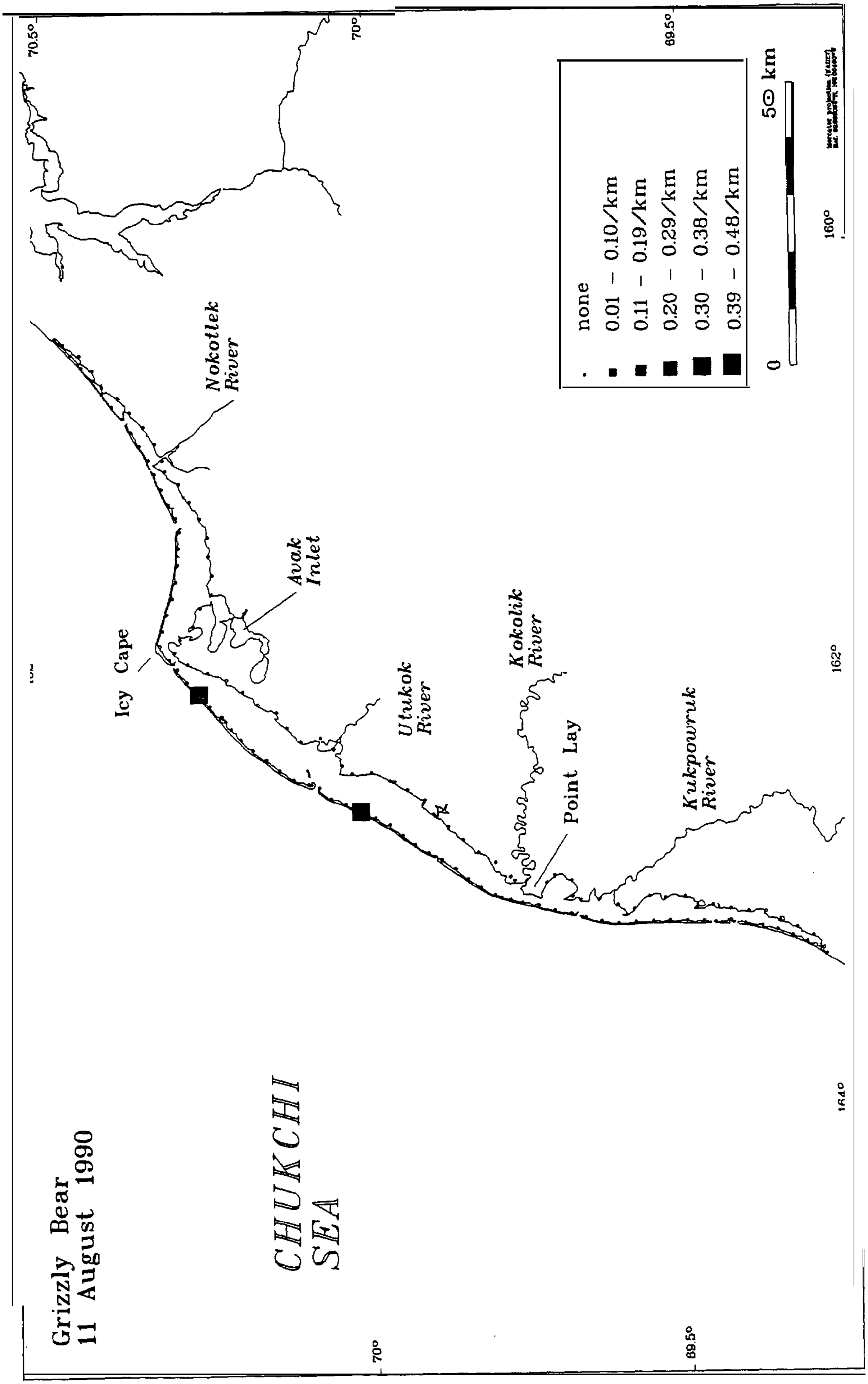

Grizzly Bear
3" September 1989
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
1620
1800
70.5°
70°
70
69.5°
69.5°
1640
162°
160°
none
0.01 – O. IO/km
0.11 – 0.19/km
0.20 – 0.29/km
0.30 - 0.38/km
0.39- 0.48/km
0
50 km



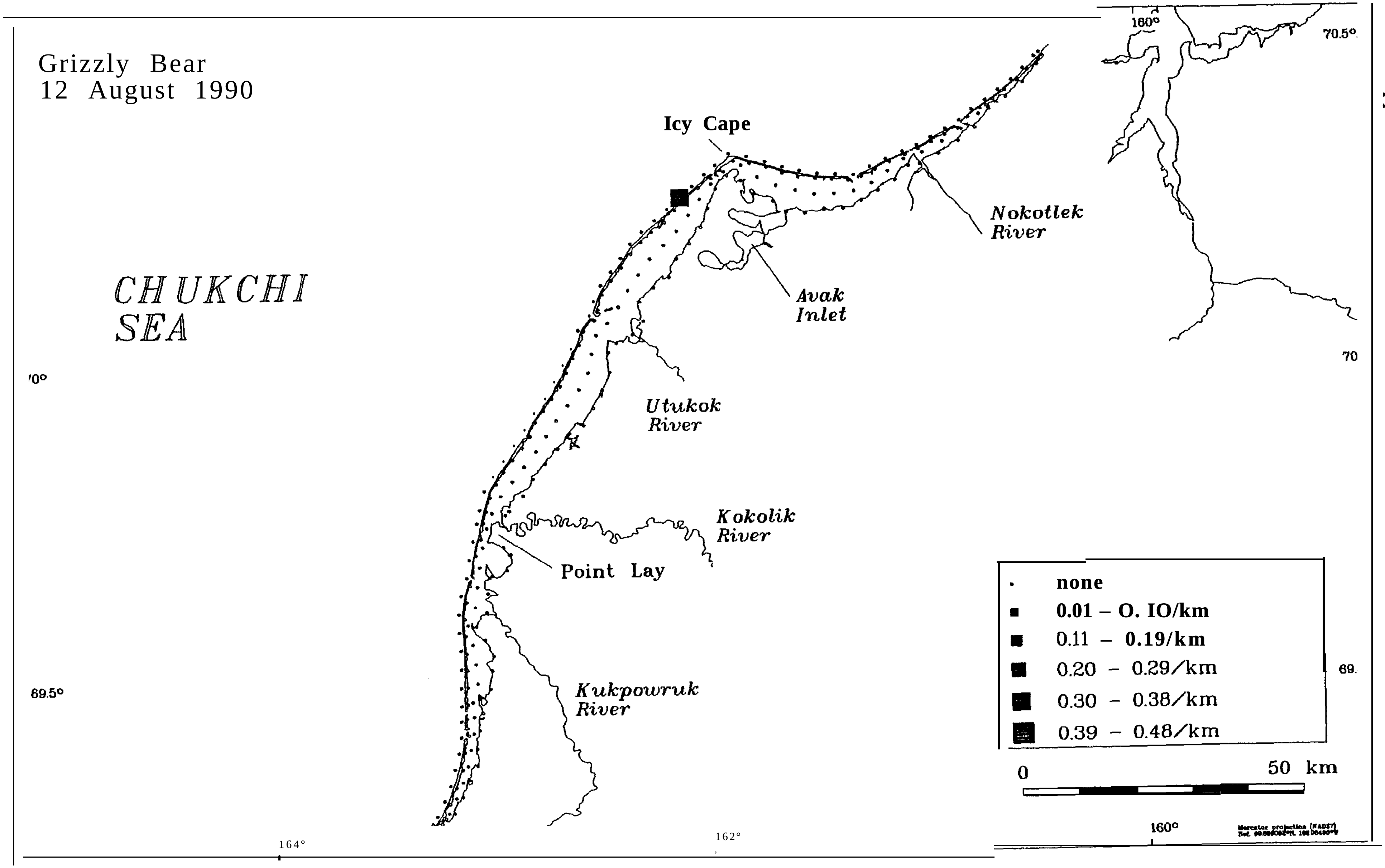
Grizzly Bear
4 September 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 0.10/km
0.11 - 0.19/km
0.20 - 0.29/km
0.30 - 0.38/km
0.39 - 0.48/km
0
0 km
70.5°
70°
69.5°
160°
164°
70°
69.5°

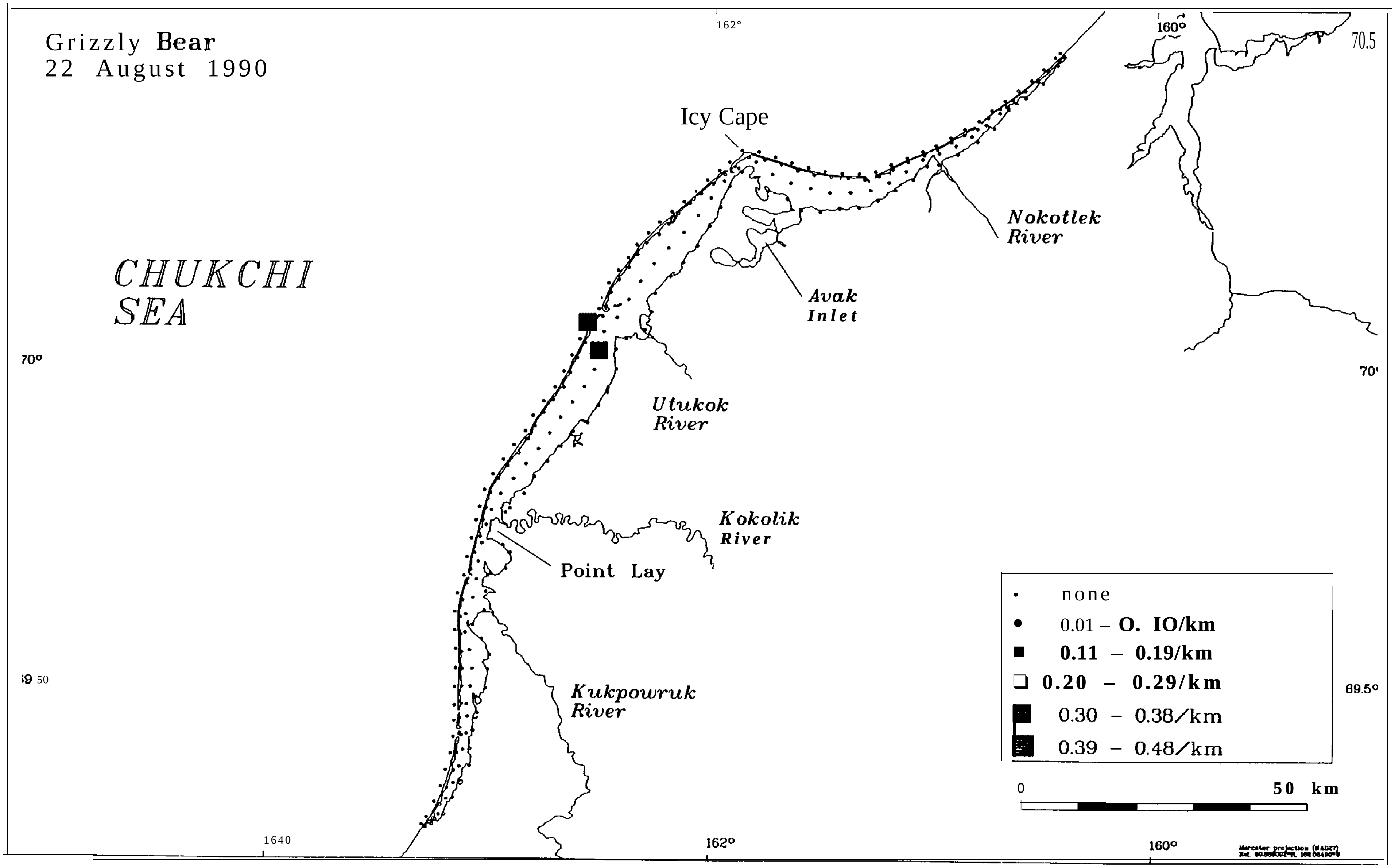

Grizzly Bear
27 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.10/km
0.11 – 0.19/km
0.20 – 0.29/km
0.30 – 0.38/km
0.39 – 0.48/km
0
50 km
160°
162°
164°
70°
69.5°
70.5°

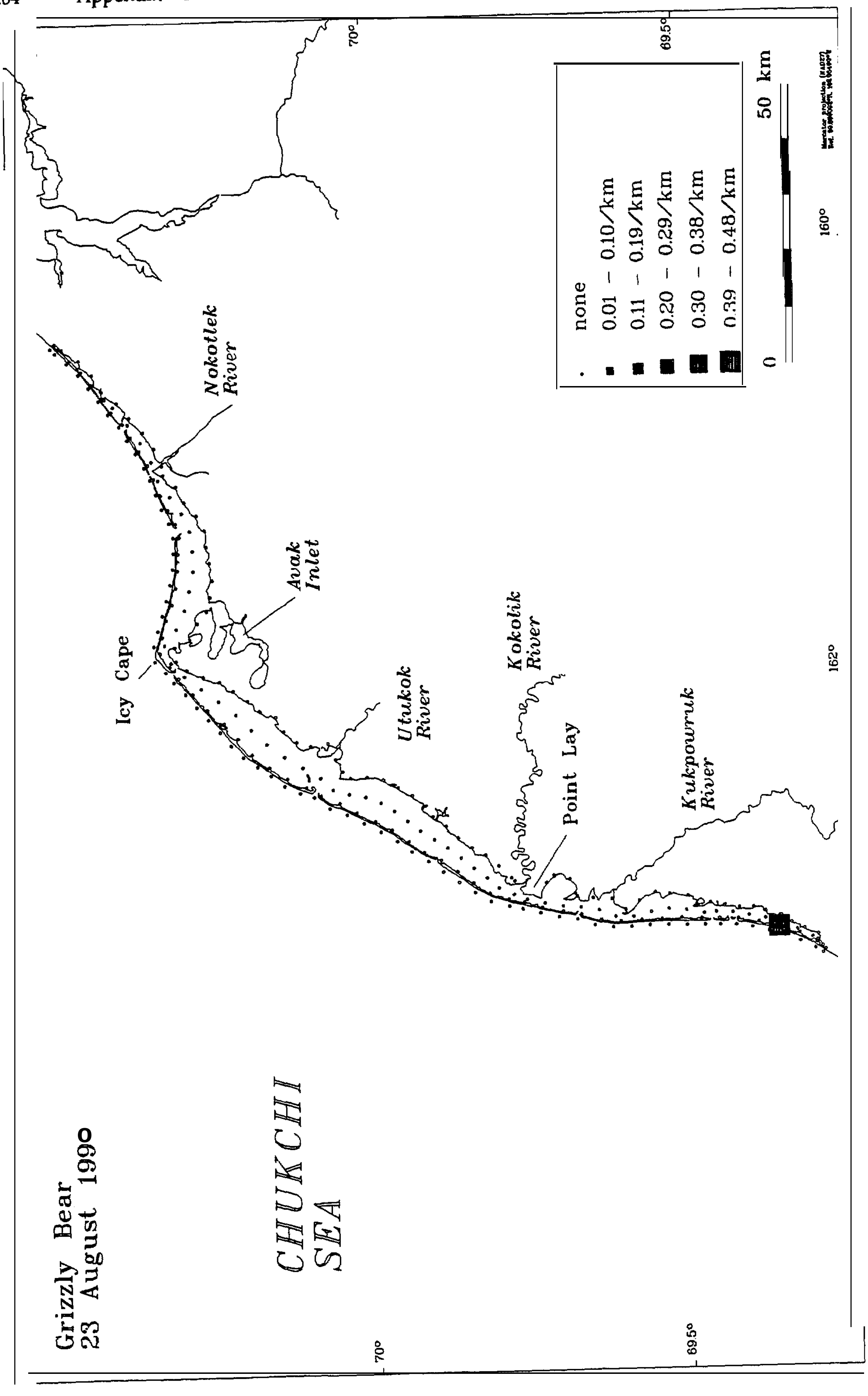

Grizzly Bear
28 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 0.10/km
0.11 - 0.19/km
0.20 - 0.29/km
0.30 - 0.38/km
0.39 - 0.48/km
0
50 km
70°
69.5°
164°
160°

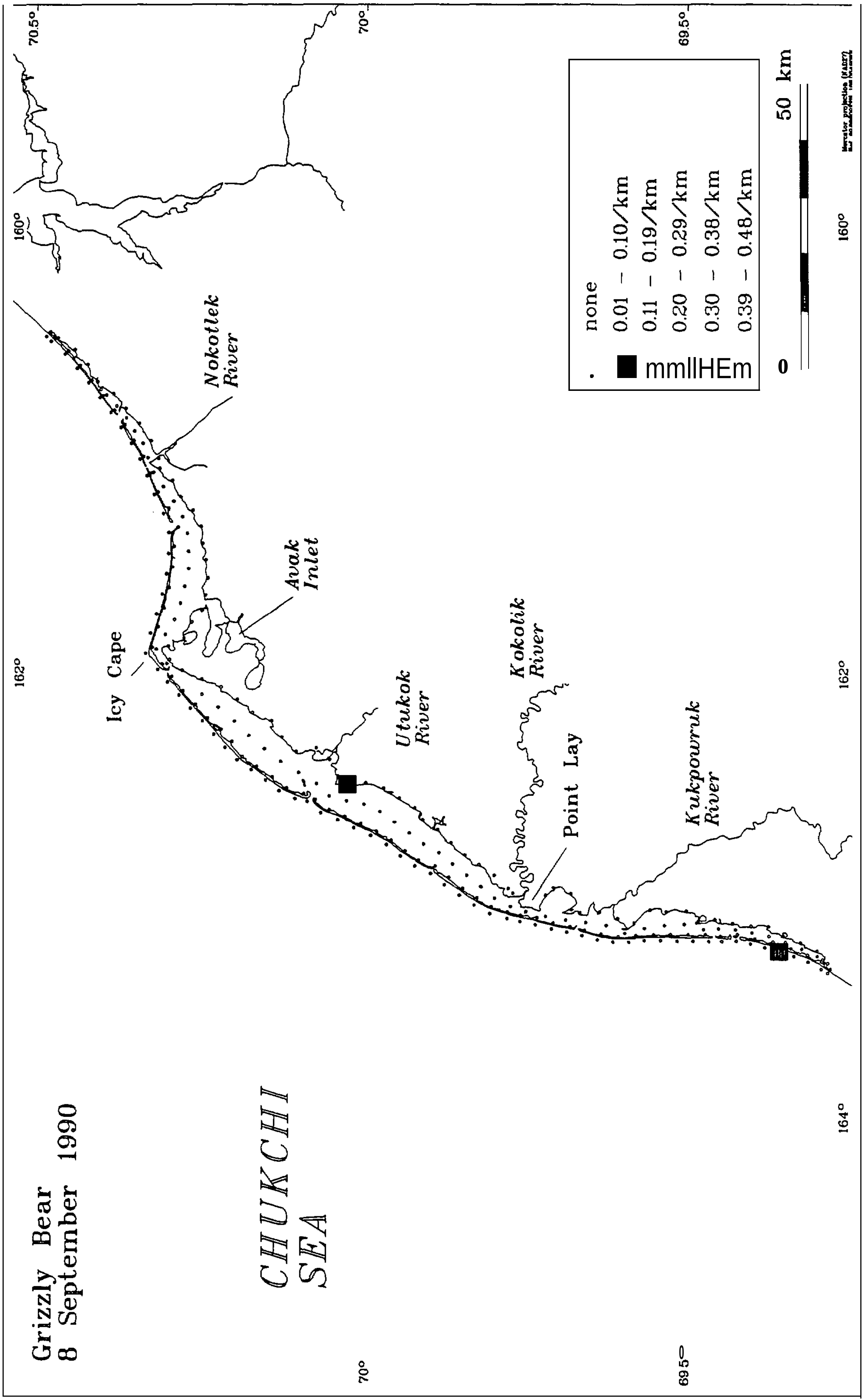

Grizzly Bear
11 August 1990
CHUKCHI
SEA
Icy Cape
Avak
Inlet
Nokotlek
River
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.10/km
0.11 – 0.19/km
0.20 – 0.29/km
0.30 – 0.38/km
0.39 – 0.48/km
0
50 km
70.5°
70°
69.5°
160°
162°

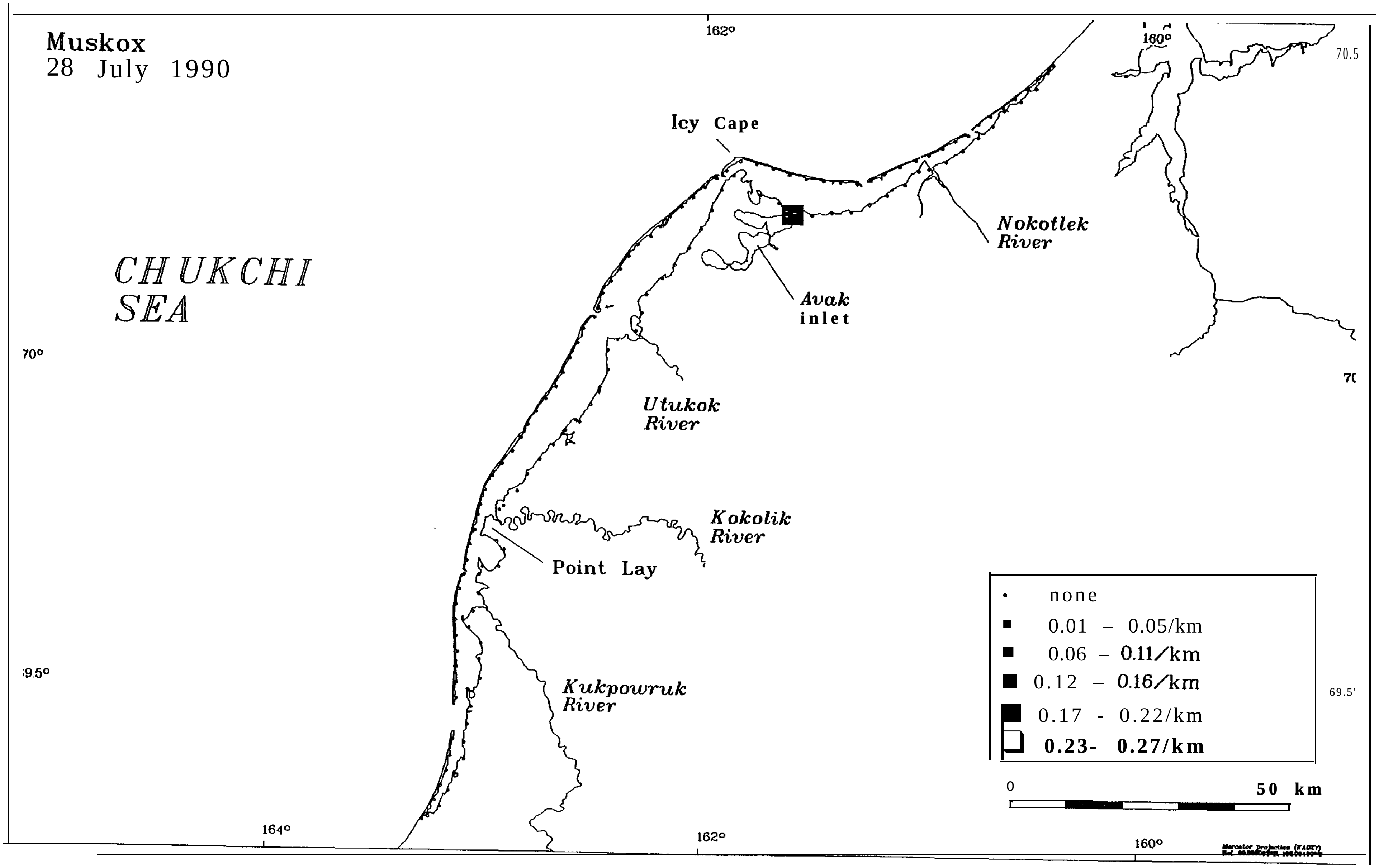
Grizzly Bear
12 August 1990

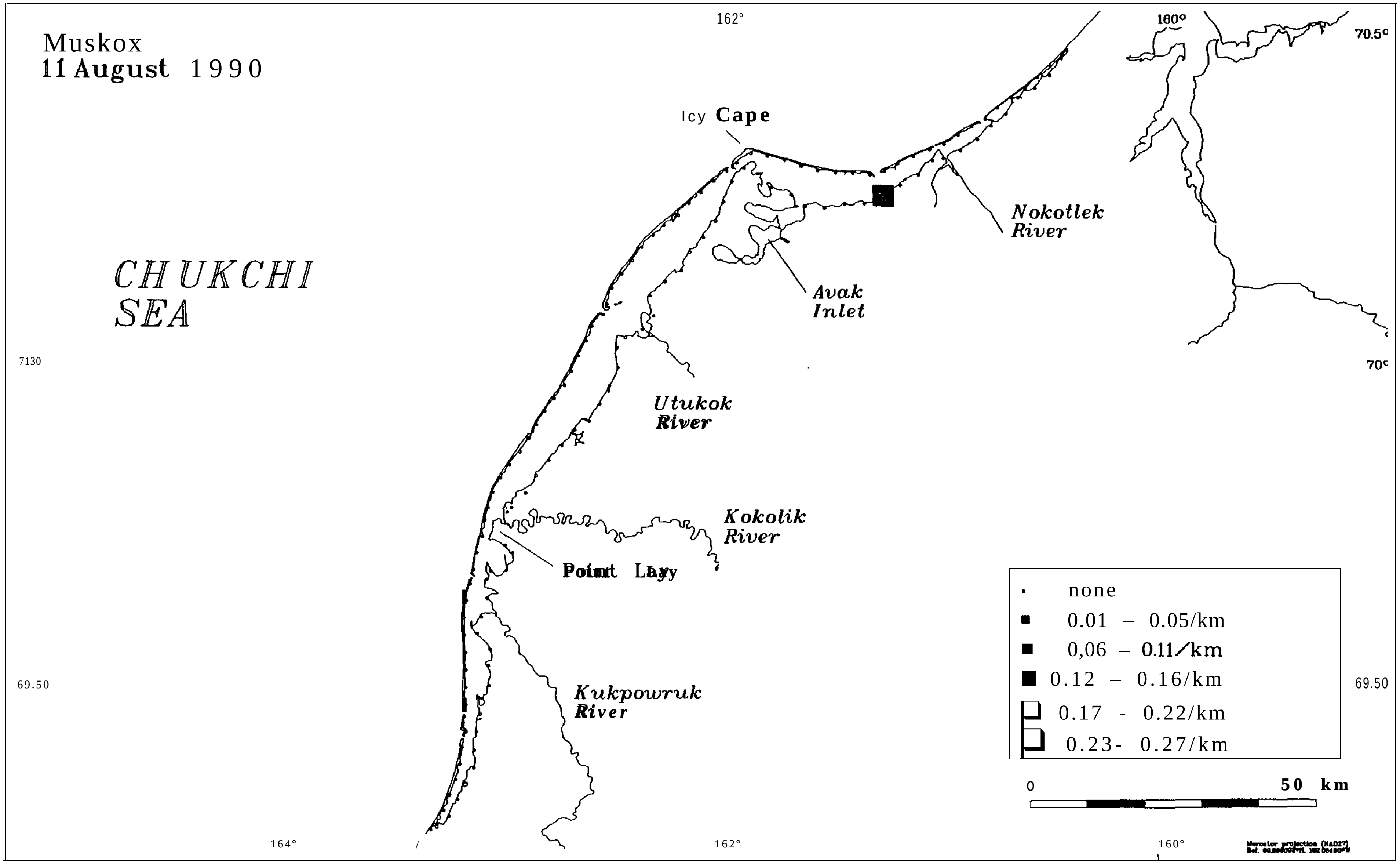



Grizzly Bear
22 August 1990
162°
160°
70.5
Icy Cape
Nokotlek
River
CHUKCHI
SEA
Avak
Inlet
70°
70°
Utukok
River
Kokolik
River
Point Lay
none
0.01 – O. IO/km
0.11 – 0.19/km
0.20 – 0.29/km
0.30 – 0.38/km
0.39 – 0.48/km
69 50
69.5°
Kukpowruk
River
0
50 km
1640
162°
160°

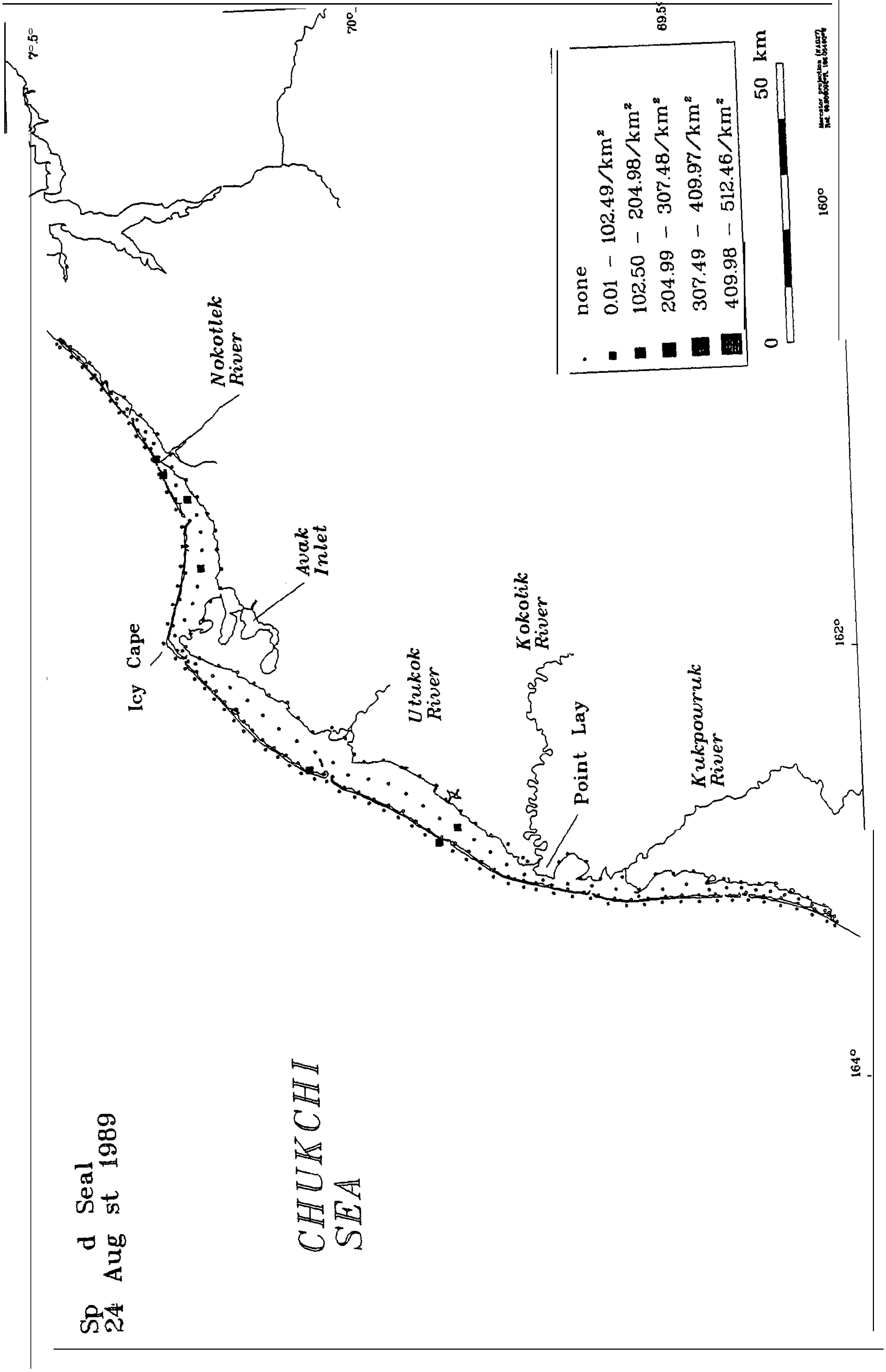

Grizzly Bear
23 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 0.10/km
0.11 - 0.19/km
0.20 - 0.29/km
0.30 - 0.38/km
0.39 - 0.48/km
0
50 km
70°
69.5°
160°
162°

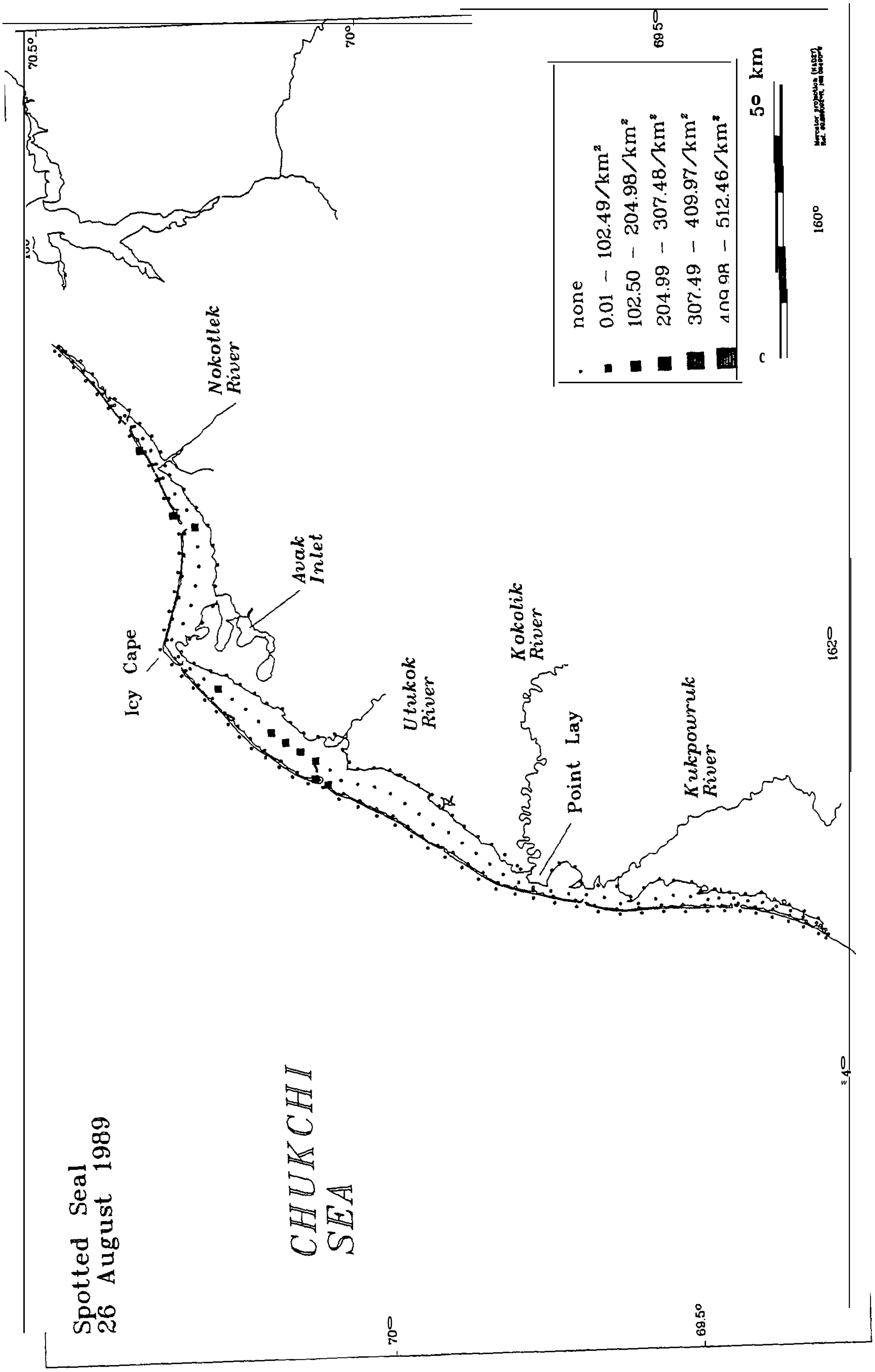

Grizzly Bear
8 September 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.10/km
0.11 – 0.19/km
0.20 – 0.29/km
0.30 – 0.38/km
0.39 – 0.48/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°

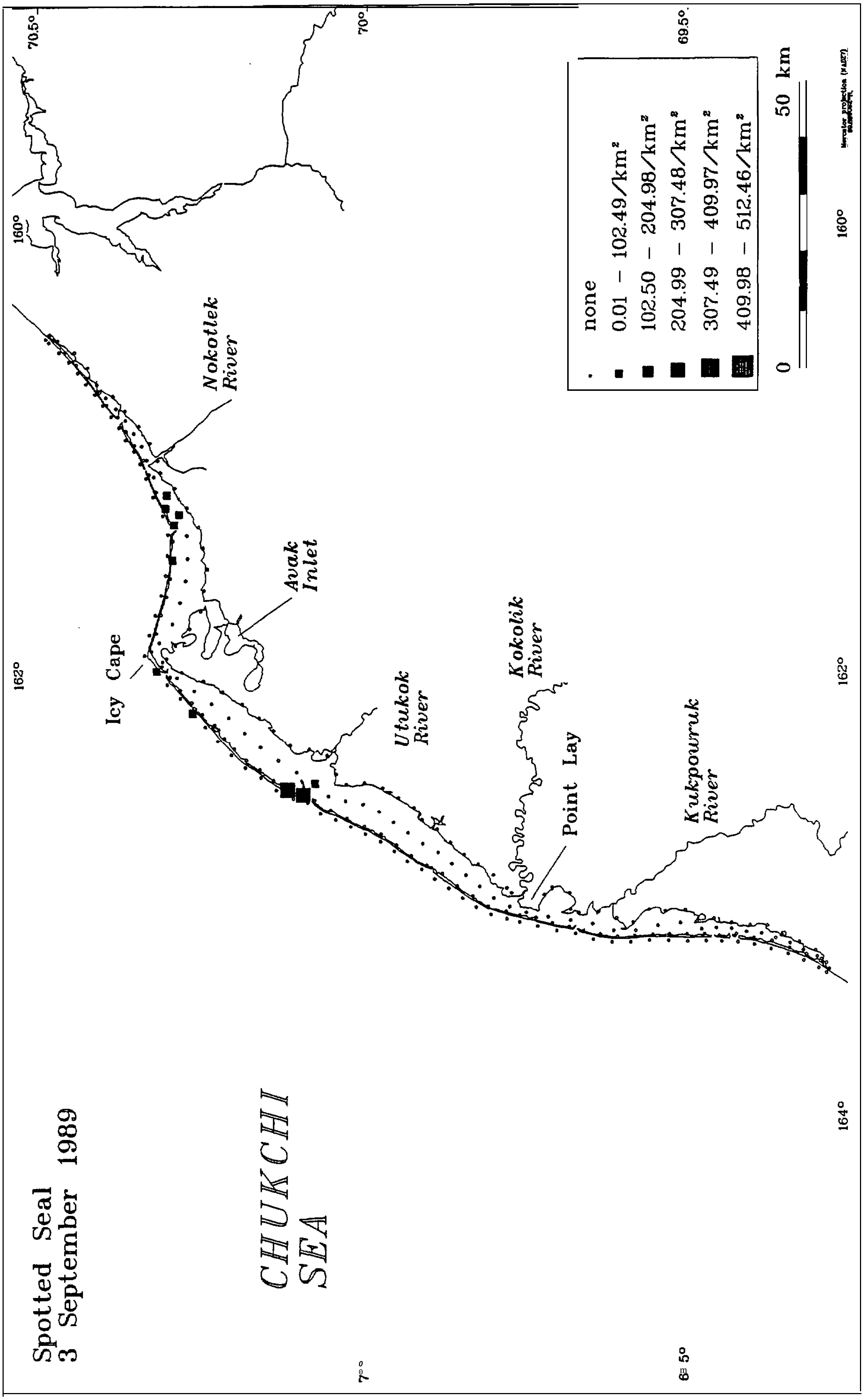

Muskox
28 July 1990
162°
160°
70.5
Icy Cape
CHUKCHI SEA
Nokotlek River
Avak inlet
70°
70
Utukok River
Kokolik River
Point Lay
9.5°
Kukpowruk River
69.5'
none
0.01 – 0.05/km
0.06 – 0.11/km
0.12 – 0.16/km
0.17 - 0.22/km
0.23- 0.27/km
0
50 km
164°
162°
160°

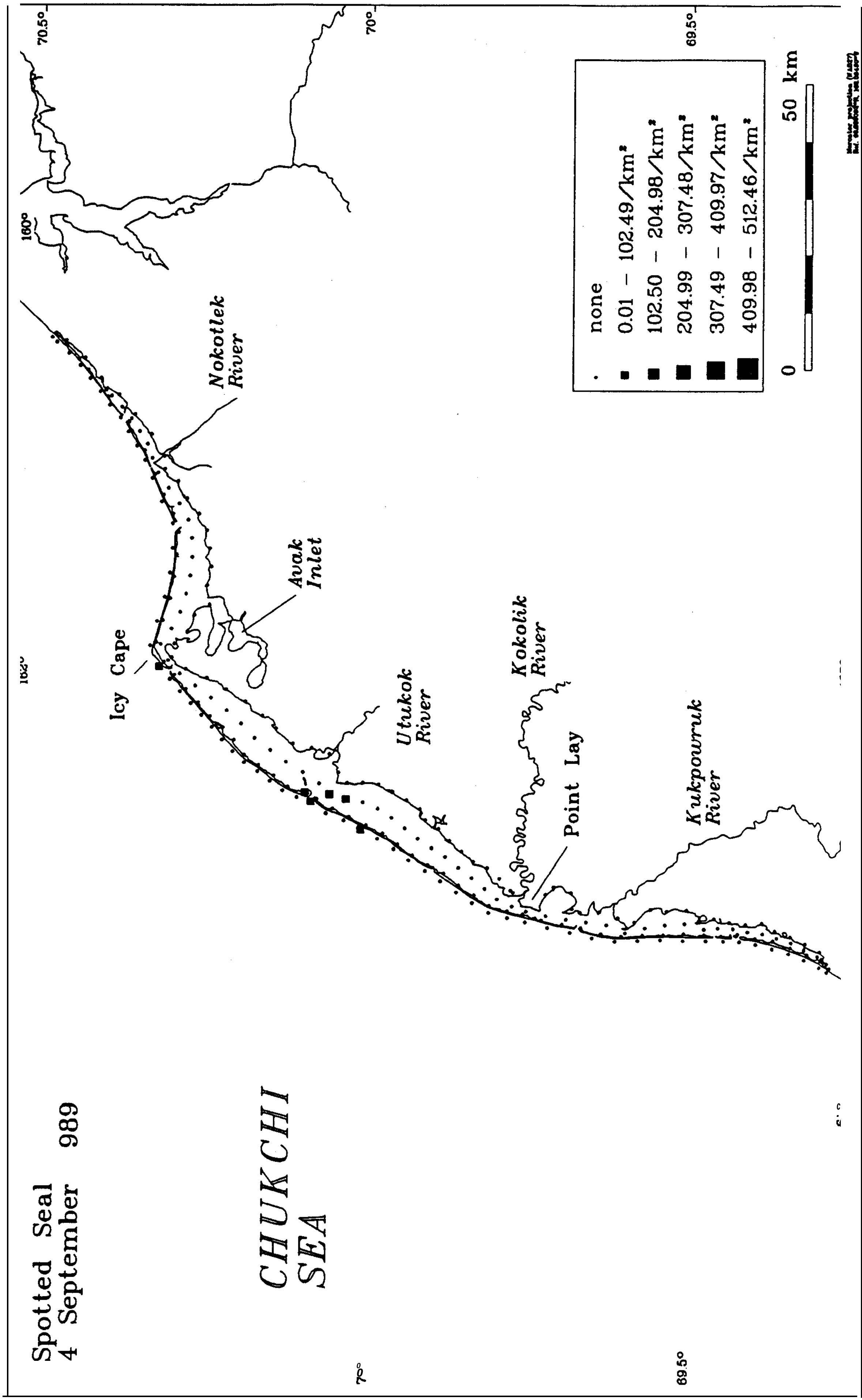


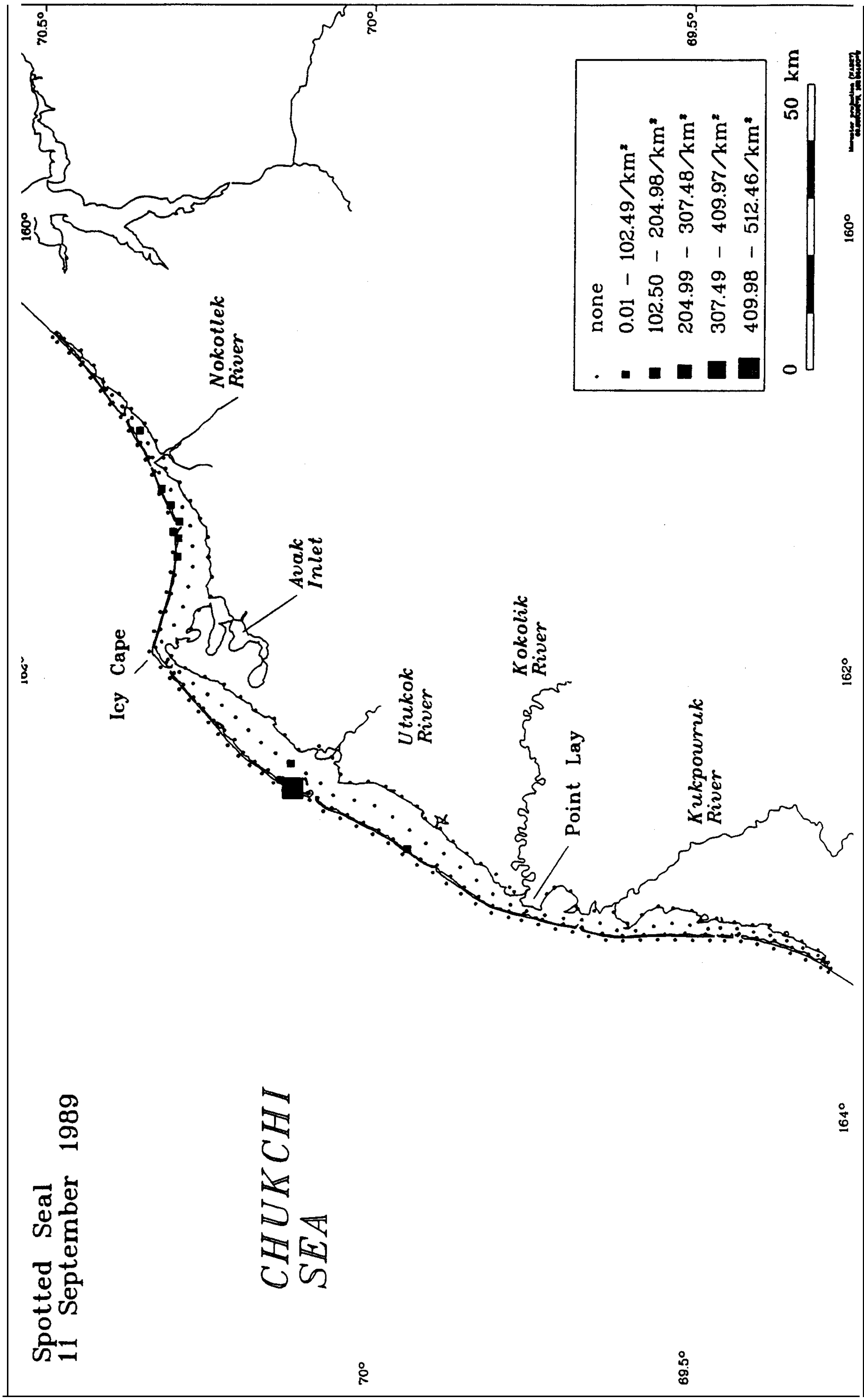
Muskox
11 August 1990
162°
160°
70.5°
Icy Cape
Nokotlek River
Avak Inlet
CHUKCHI SEA
7130
70°
Utukok River
Kokolik River
Point Lay
none
0.01 – 0.05/km
0,06 – 0.11/km
0.12 – 0.16/km
0.17 - 0.22/km
0.23- 0.27/km
0
50 km
69.50
69.50
Kukpowruk River
164°
162°
160°

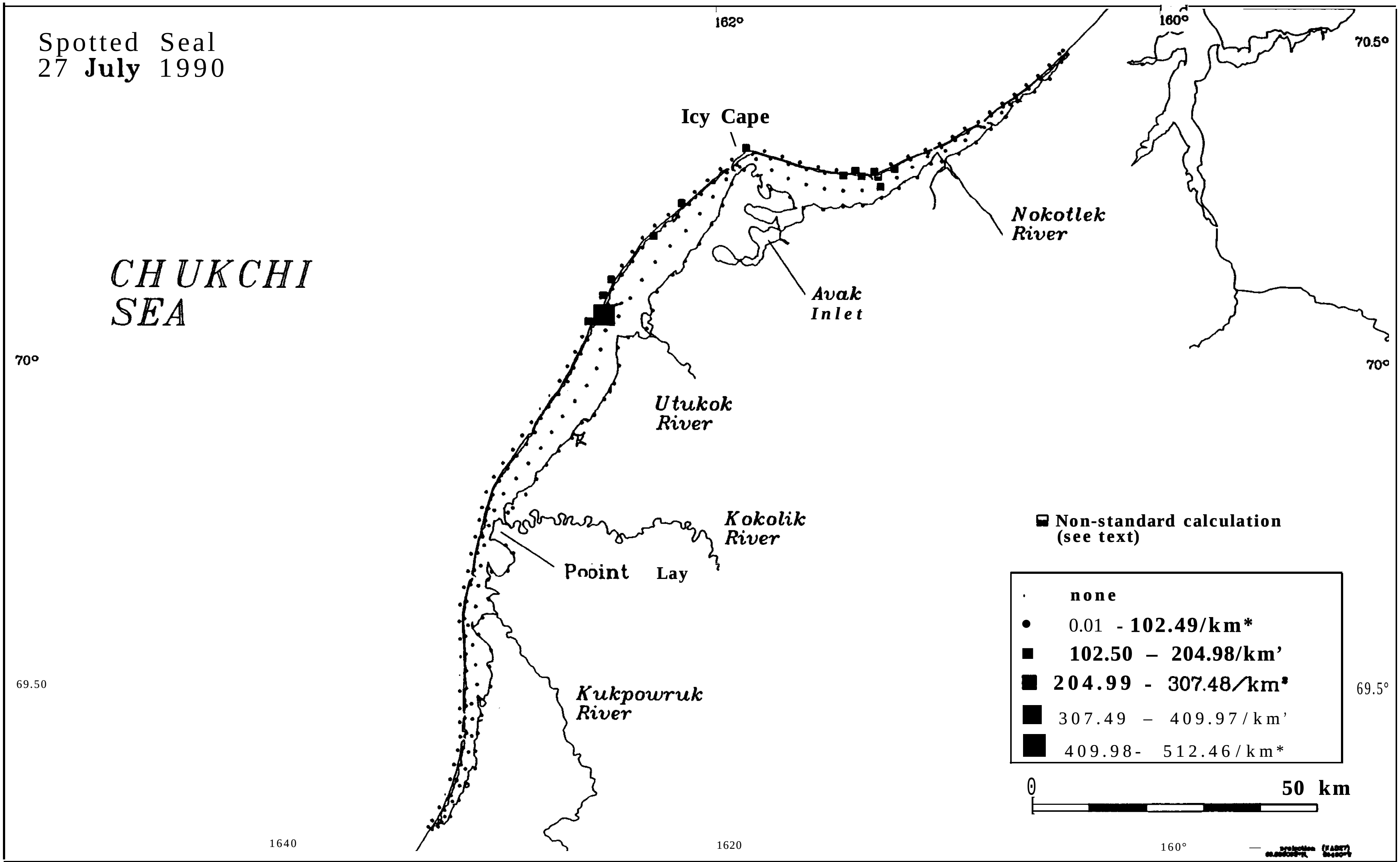

Sp d Seal
24 Aug st 1989
CHUKCHI
SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 102.49/km²
102.50 – 204.98/km²
204.99 – 307.48/km²
307.49 – 409.97/km²
409.98 – 512.46/km²
0
50 km
70°
69.5°
160°
162°
164°

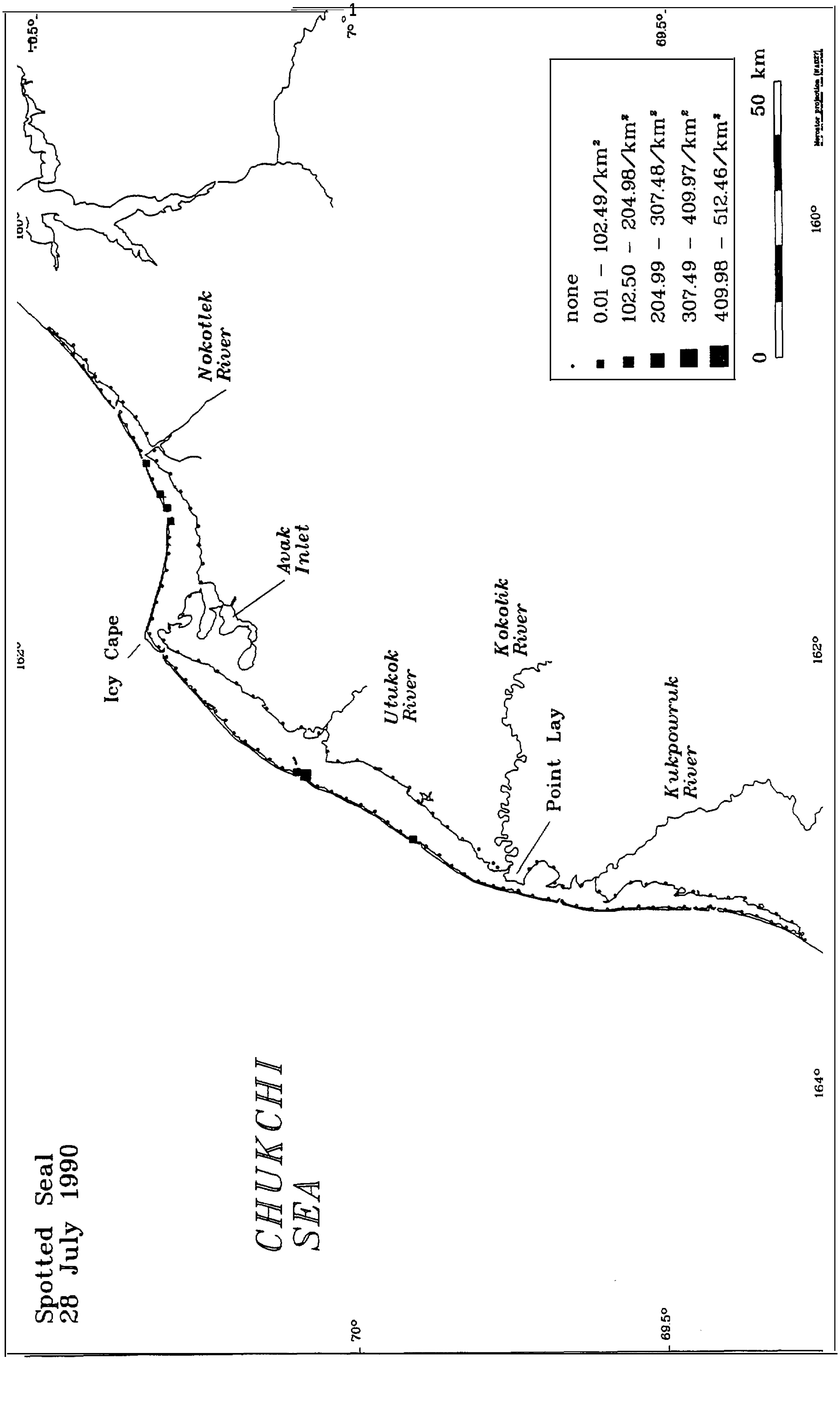

Spotted Seal
26 August 1989
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 102.49/km²
102.50 – 204.98/km²
204.99 – 307.48/km²
307.49 – 409.97/km²
– 512.46/km²
50 km
70.5°
70°
69.5°
160°
162°

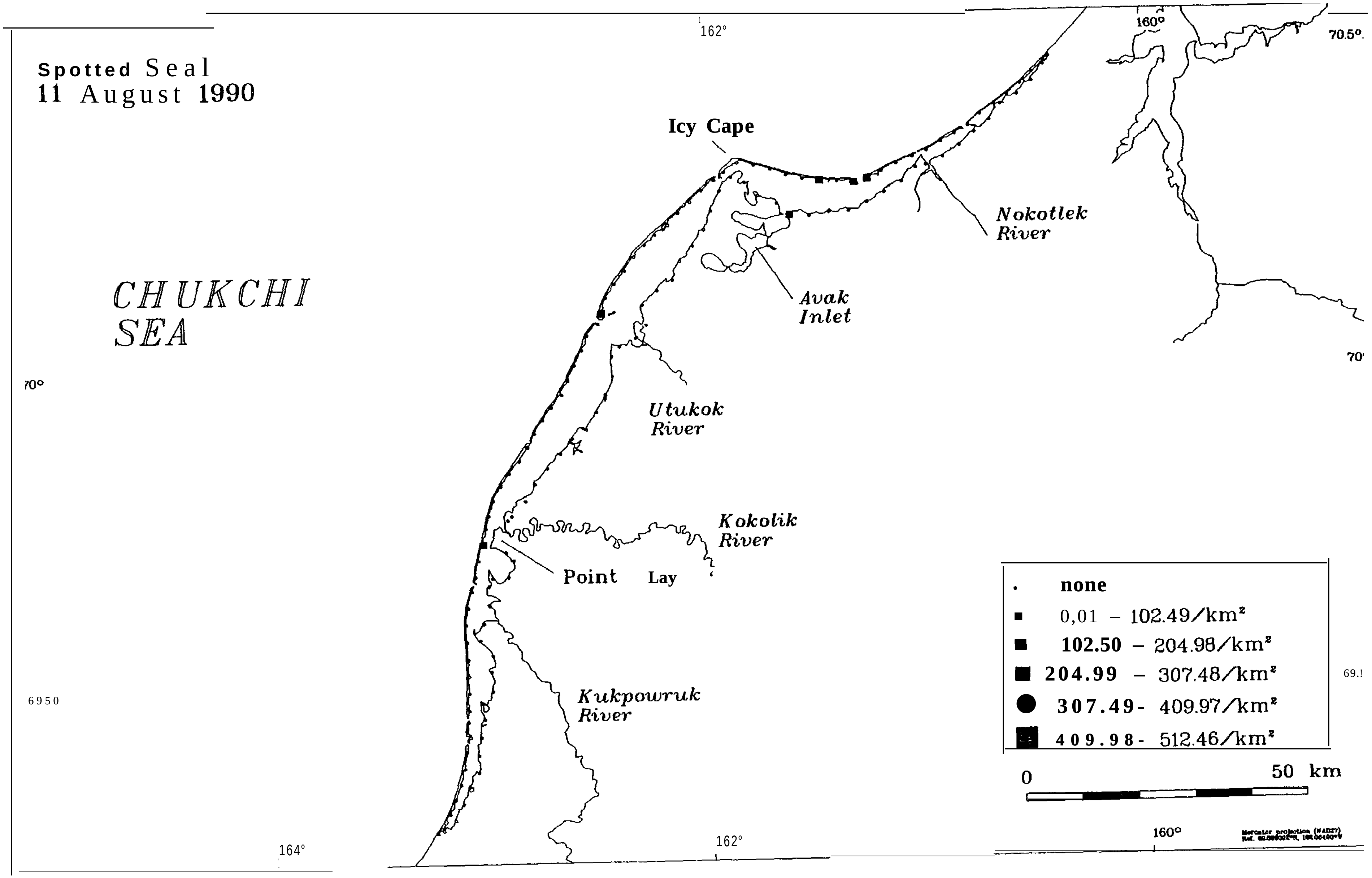

Spotted Seal
3 September 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 102.49/km²
102.50 – 204.98/km²
204.99 – 307.48/km²
307.49 – 409.97/km²
409.98 – 512.46/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

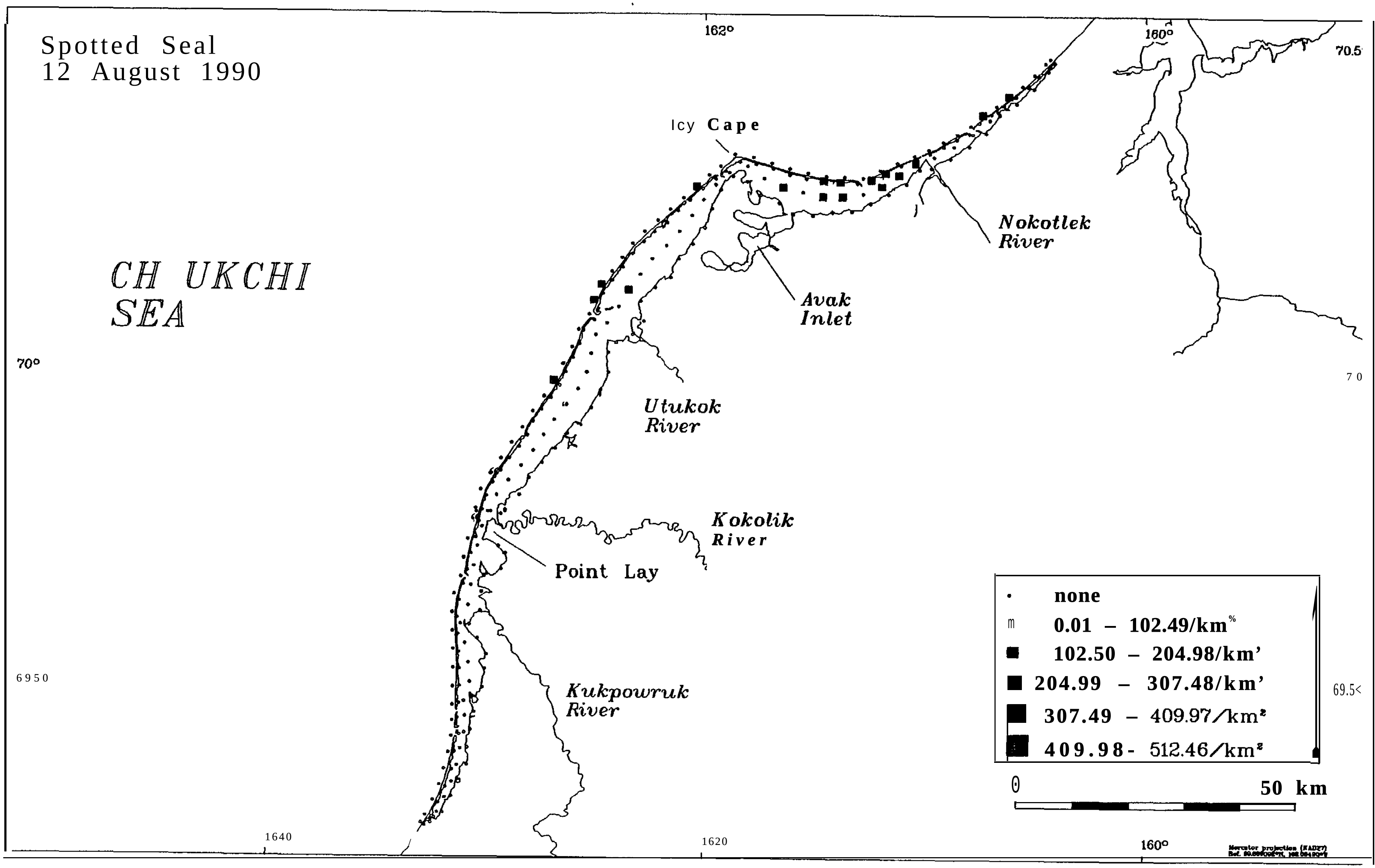

Spotted Seal
4 September 989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 102.49/km²
102.50 - 204.98/km²
204.99 - 307.48/km²
307.49 - 409.97/km²
409.98 - 512.46/km²
0
50 km
70.5°
70°
69.5°
160°
162°
70°
69.5°

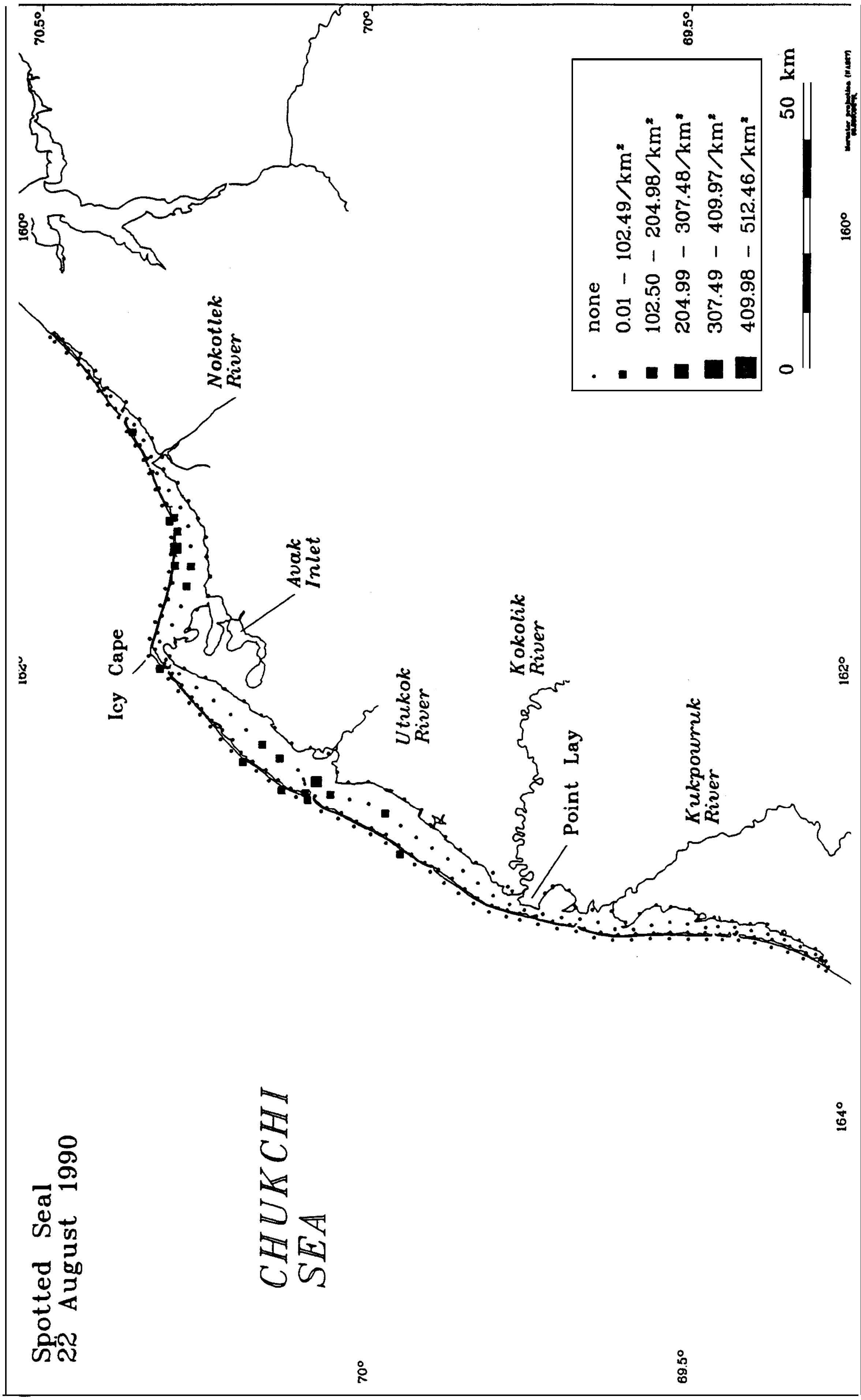

Spotted Seal
11 September 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 - 102.49/km²
102.50 - 204.98/km²
204.99 - 307.48/km²
307.49 - 409.97/km²
409.98 - 512.46/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

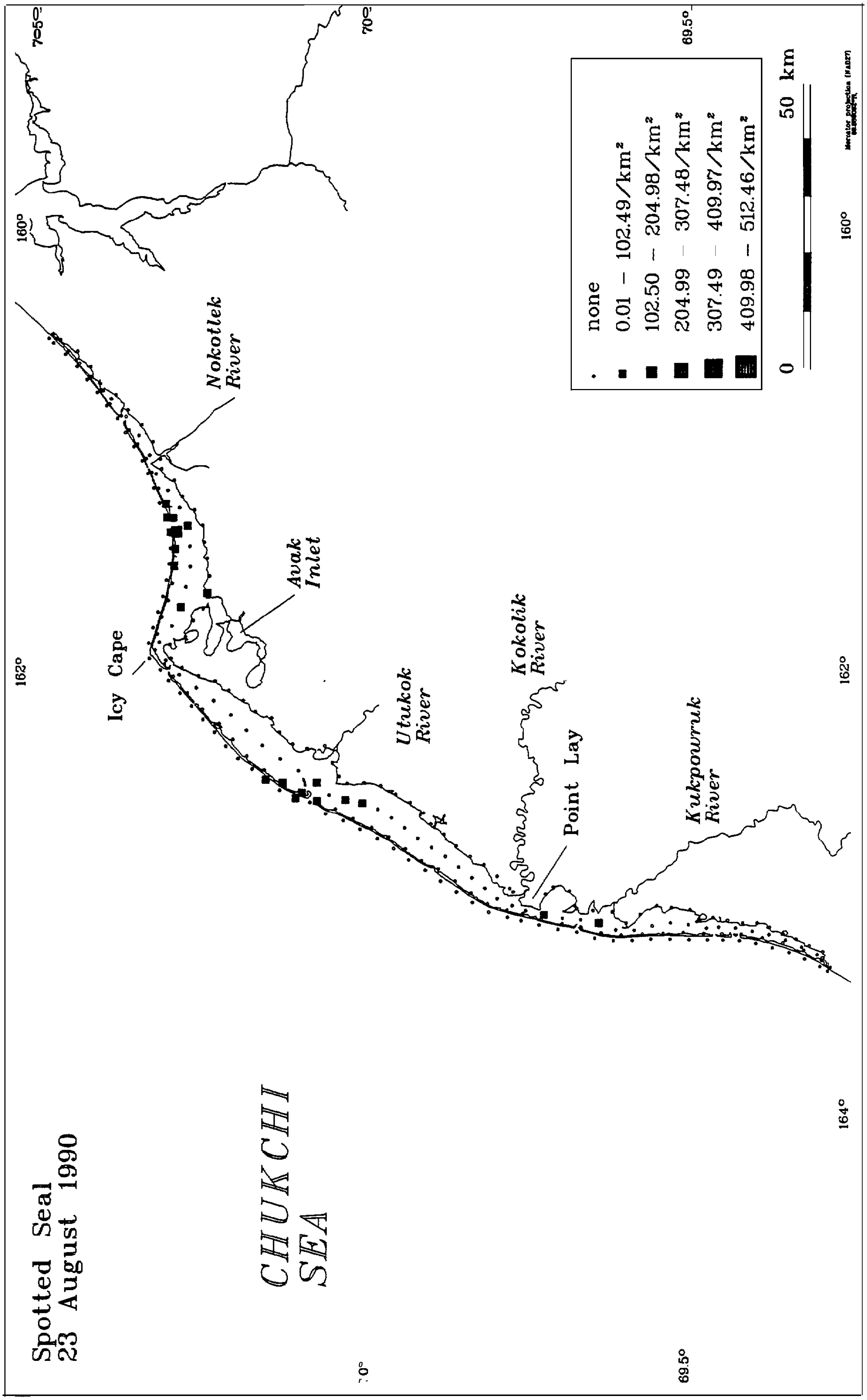

Spotted Seal
27 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Pooint Lay
Kukpowruk
River
162°
160°
70.5°
70°
70°
69.50
69.5°
1640
1620
160°
Non-standard calculation
(see text)
none
0.01 - 102.49/km*
102.50 – 204.98/km'
204.99 - 307.48/km²
307.49 – 409.97/km'
409.98- 512.46/km*
0
50 km

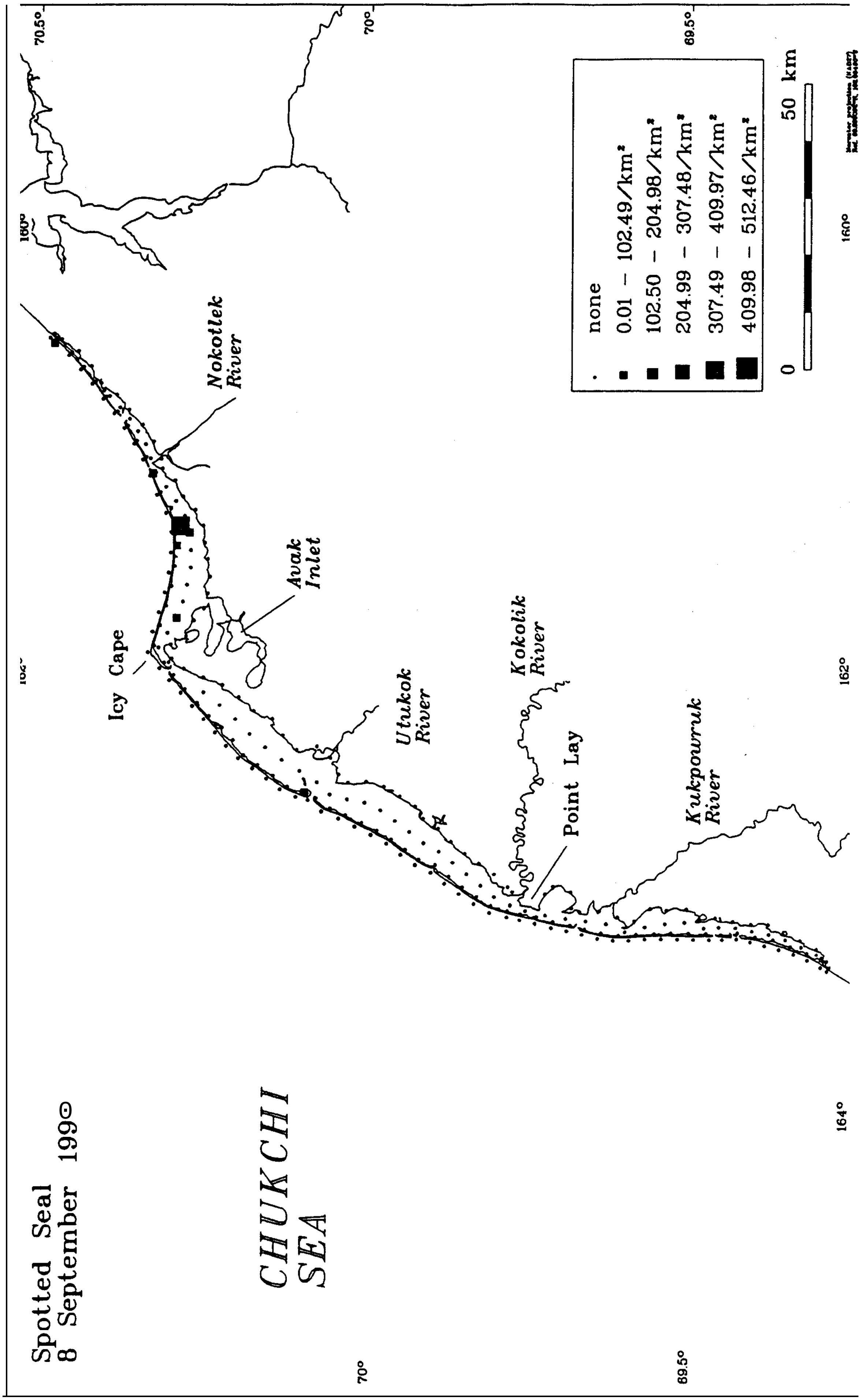

Spotted Seal
28 July 1990
CHUKCHI
SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
none
0.01 – 102.49/km²
102.50 – 204.98/km²
204.99 – 307.48/km²
307.49 – 409.97/km²
409.98 – 512.46/km²
0
50 km
70°
69.5°
160°
162°
164°

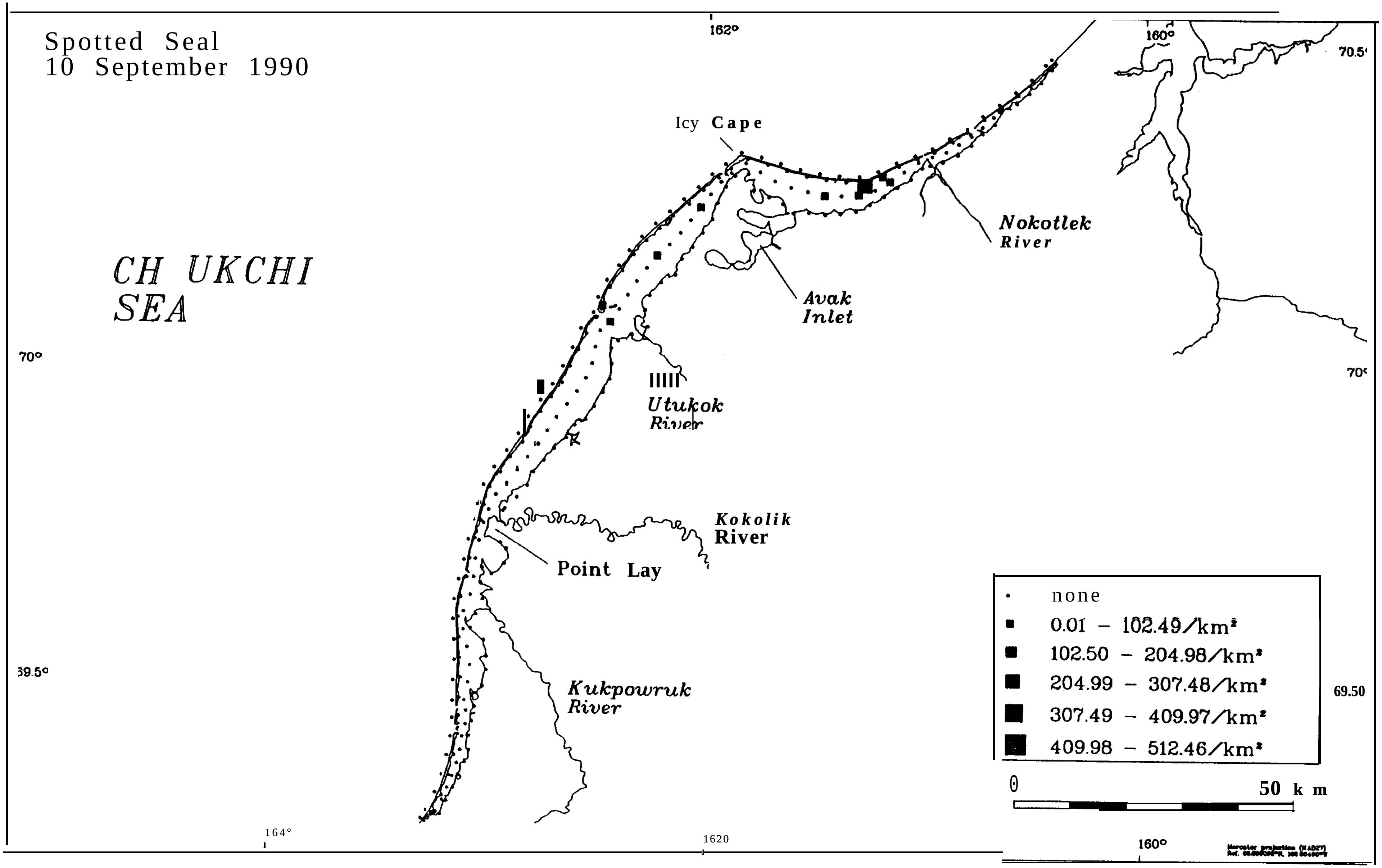

Spotted Seal
11 August 1990
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
164°
6950
none
0,01 – 102.49/km²
102.50 – 204.98/km²
204.99 – 307.48/km²
307.49 - 409.97/km²
409.98 - 512.46/km²
0
50 km

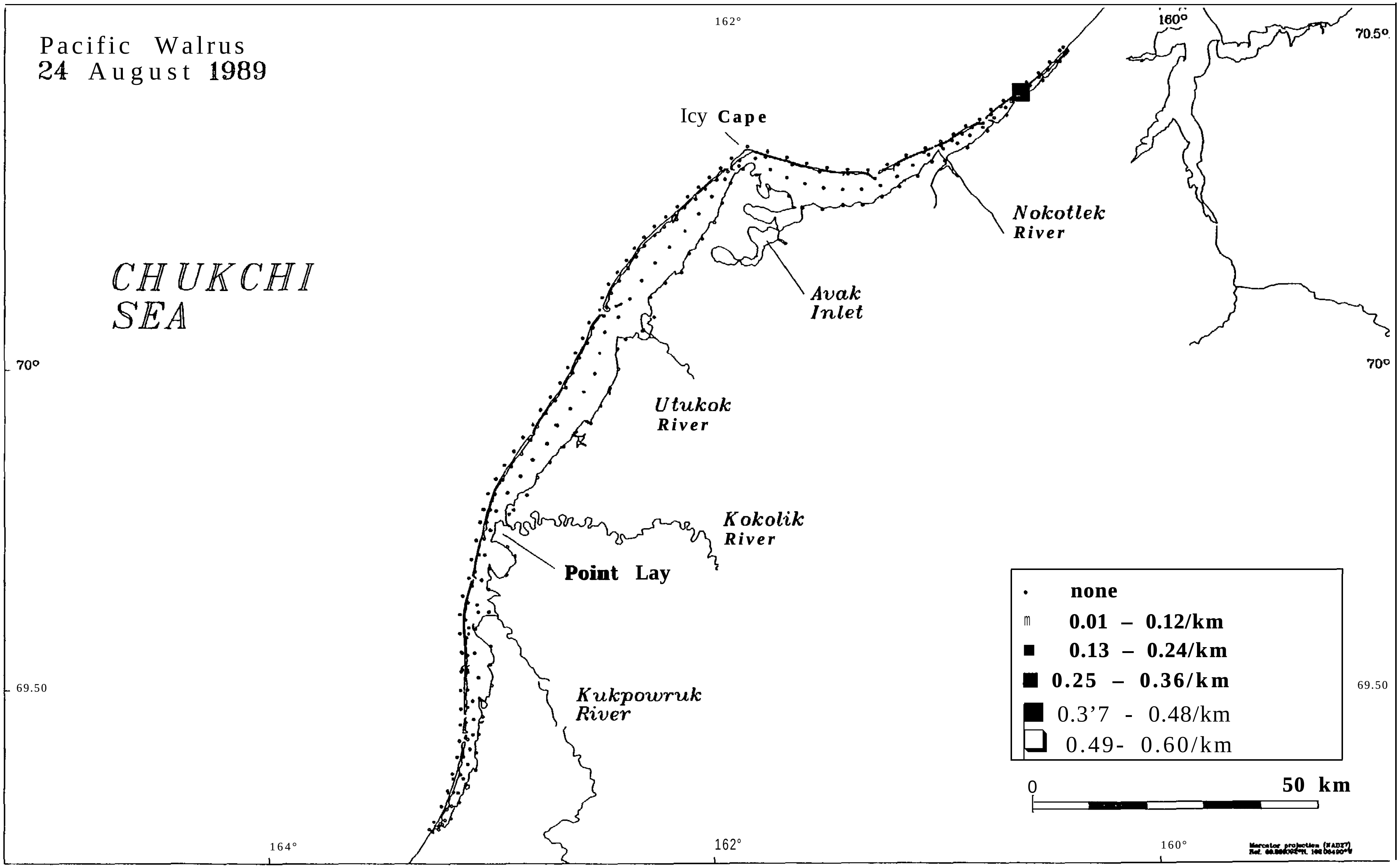

Spotted Seal
12 August 1990
Icy Cape
CH UKCHI SEA
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5
70°
70
6950
69.5
1640
1620
160°
none
0.01 – 102.49/km²
102.50 – 204.98/km²
204.99 – 307.48/km²
307.49 – 409.97/km²
409.98 - 512.46/km²
0
50 km

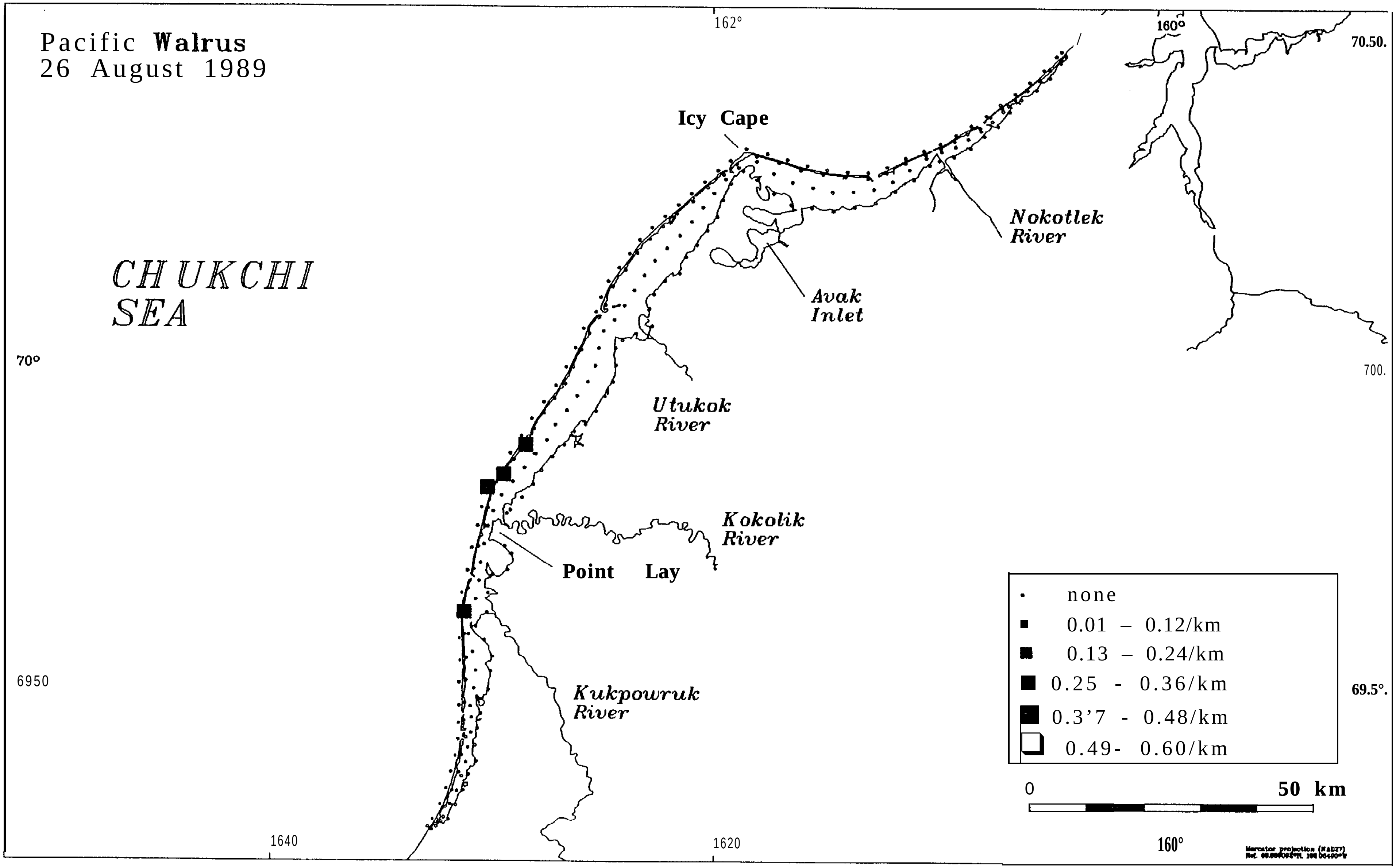

Spotted Seal
22 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 102.49/km²
102.50 – 204.98/km²
204.99 – 307.48/km²
307.49 – 409.97/km²
409.98 – 512.46/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°


Spotted Seal
23 August 1990
CHUKCHI SEA
Nokotlek River
Avak Inlet
Icy Cape
Kokolik River
Utukok River
Point Lay
Kukpowruk River
none
0.01 – 102.49/km²
102.50 – 204.98/km²
204.99 – 307.48/km²
307.49 – 409.97/km²
409.98 – 512.46/km²
0
50 km
160°
162°
164°
70°
69.5°

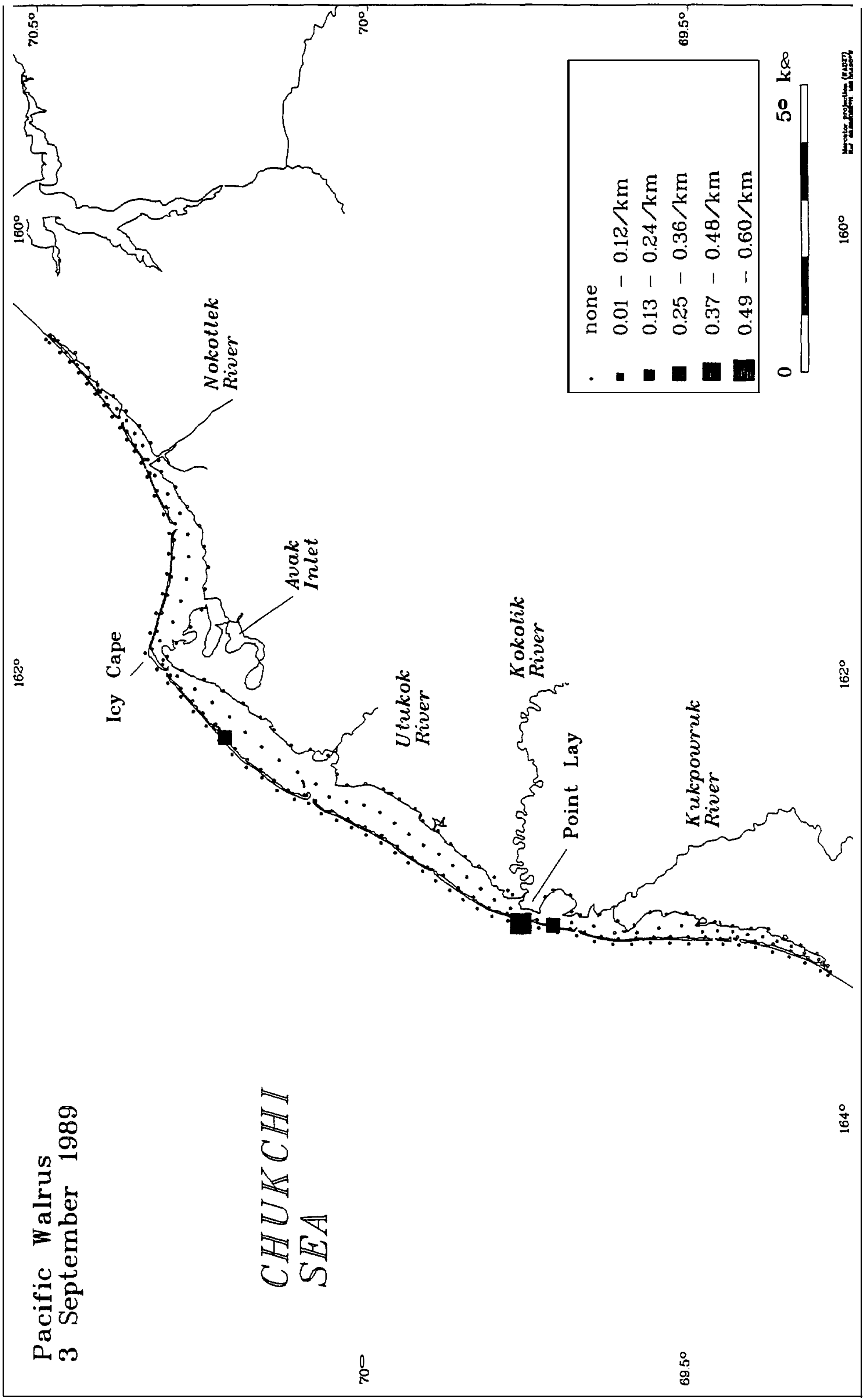

Spotted Seal
8 September 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 102.49/km²
102.50 – 204.98/km²
204.99 – 307.48/km²
307.49 – 409.97/km²
409.98 – 512.46/km²
0
50 km
70.5°
70°
69.5°
160°
162°
164°

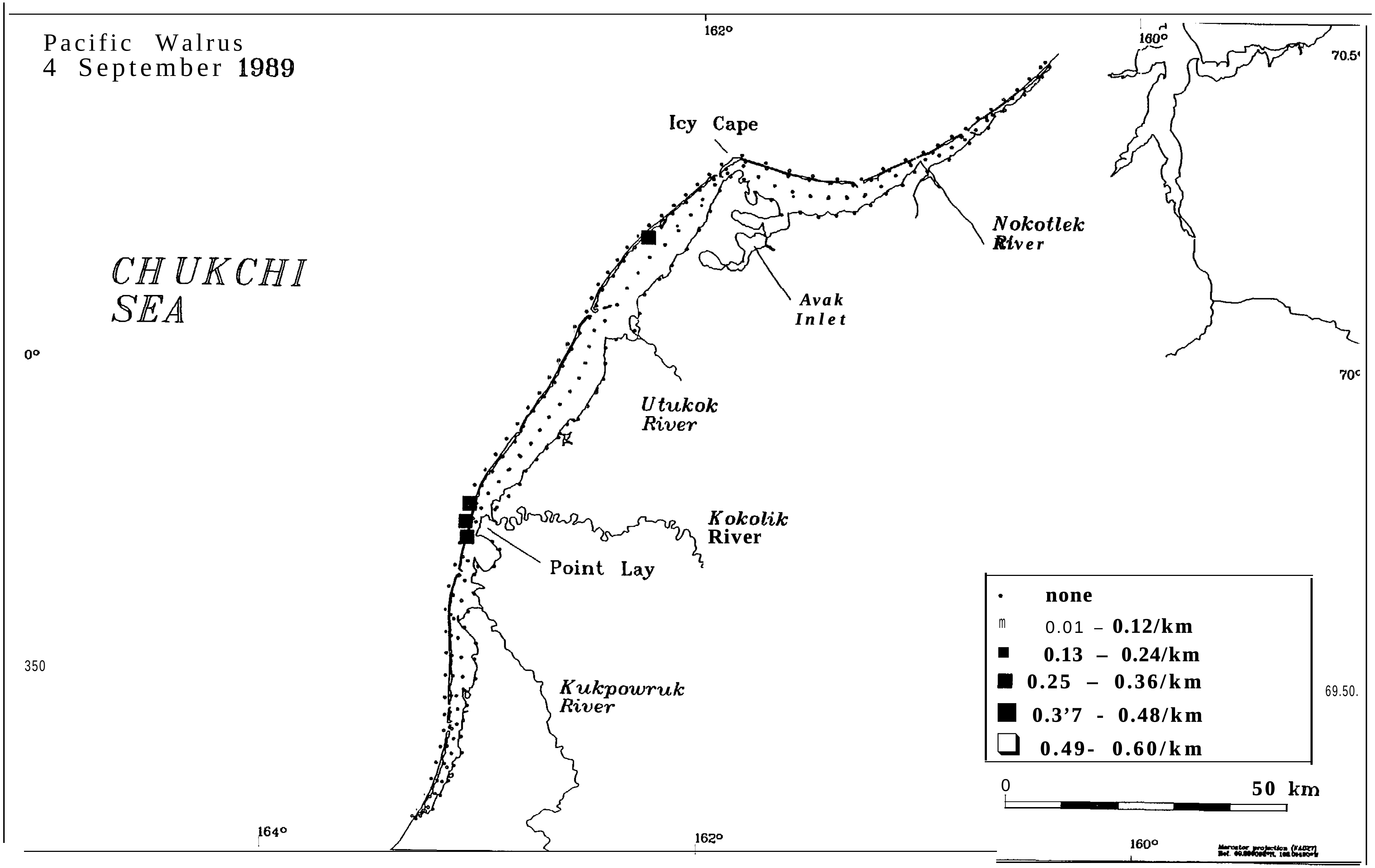

Spotted Seal
10 September 1990
CH UKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 102.49/km²
102.50 – 204.98/km²
204.99 – 307.48/km²
307.49 – 409.97/km²
409.98 – 512.46/km²
0
50 k m
162°
160°
70.5°
70°
69.5°
164°
1620
160°


Pacific Walrus
24 August 1989
CHUKCHI SEA
Icy Cape
Nokotlek River
Avak Inlet
Utukok River
Kokolik River
Point Lay
Kukpowruk River
162°
160°
70.5°
70°
69.50
164°
none
0.01 – 0.12/km
0.13 – 0.24/km
0.25 – 0.36/km
0.3'7 - 0.48/km
0.49- 0.60/km
0
50 km



Pacific Walrus
26 August 1989
162°
160°
70.50.
Icy Cape
Nokotlek River
CHUKCHI SEA
Avak Inlet
70°
700.
Utukok River
Kokolik River
Point Lay
none
0.01 – 0.12/km
0.13 – 0.24/km
0.25 - 0.36/km
0.3'7 - 0.48/km
0.49- 0.60/km
6950
69.5°.
Kukpowruk River
0
50 km
1640
1620
160°


Pacific Walrus
3 September 1989
CHUKCHI
SEA
Nokotlek
River
Avak
Inlet
Icy Cape
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.12/km
0.13 – 0.24/km
0.25 – 0.36/km
0.37 – 0.48/km
0.49 – 0.60/km
0
50 km
70.5°
70°
69.5°
160°
162°
164°


Pacific Walrus
4 September 1989
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
162°
160°
70.5°
70°
0°
350
69.50.
164°
162°
160°
none
0.01 – 0.12/km
0.13 – 0.24/km
0.25 – 0.36/km
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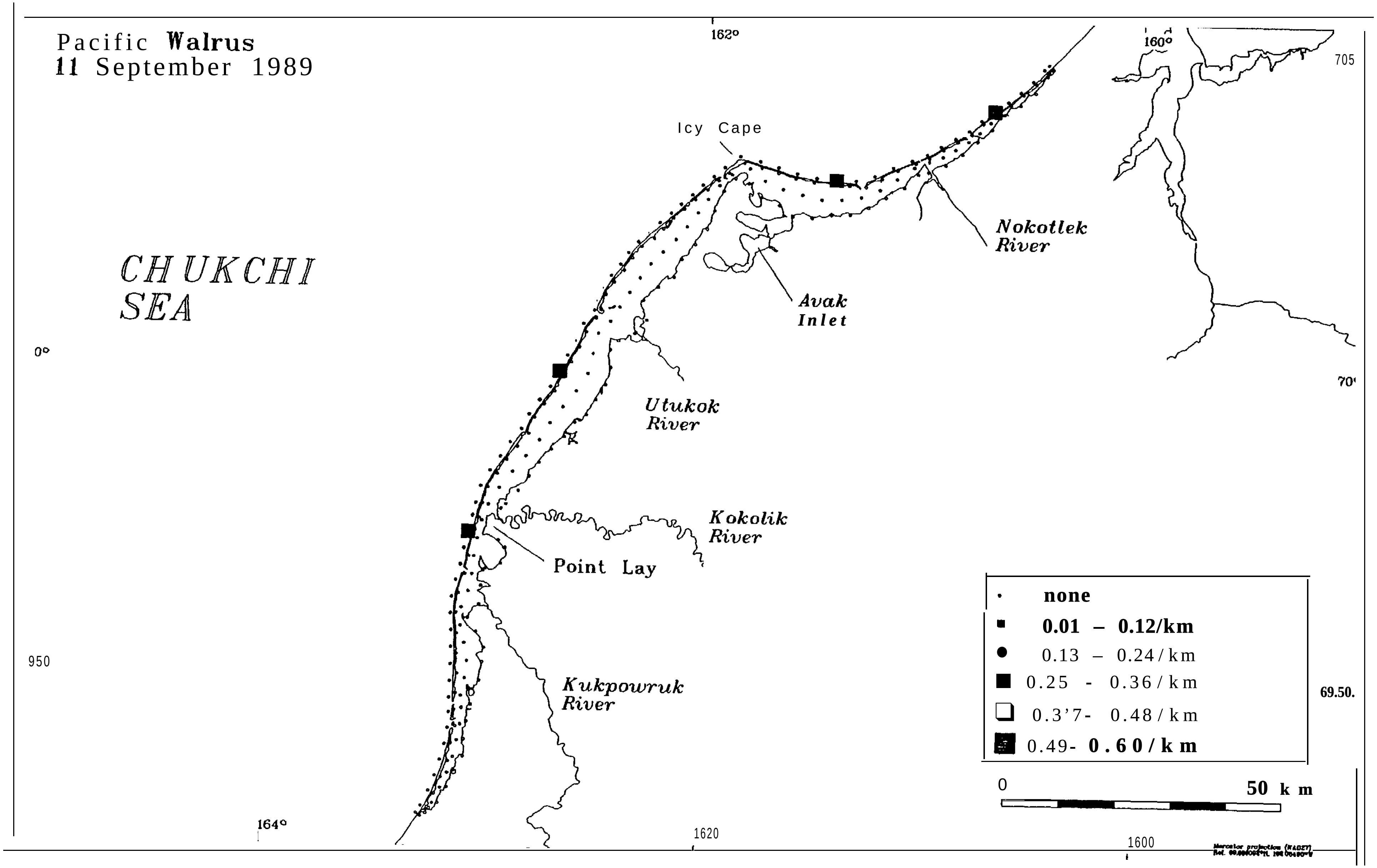
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162°
160°
705
Icy Cape
CHUKCHI SEA
Nokotlek River
Avak Inlet
0°
70°
Utukok River
Kokolik River
Point Lay
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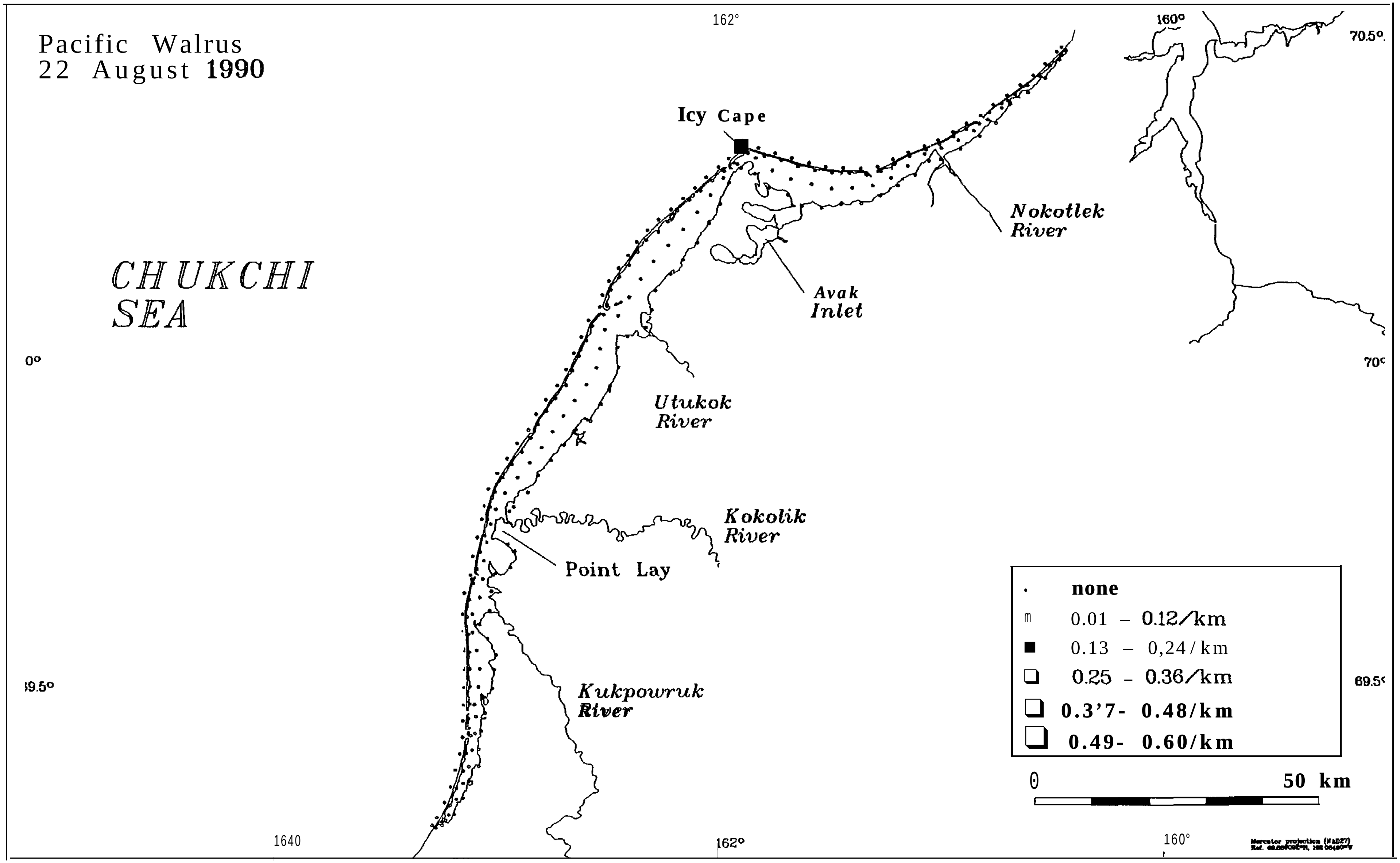

Pacific Walrus
22 August 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.12/km
0.13 – 0,24/km
0.25 – 0.36/km
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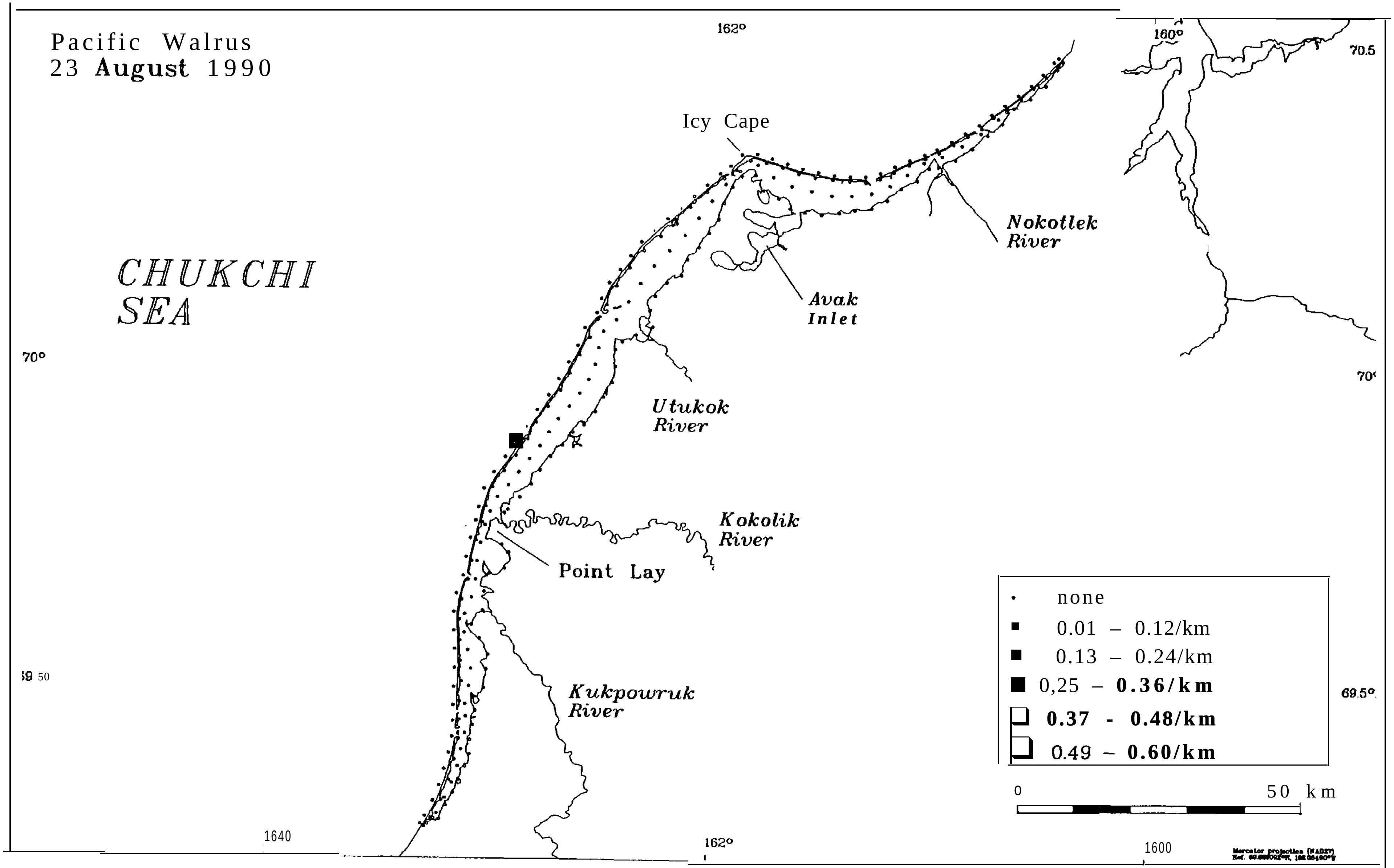

Pacific Walrus
23 August 1990
162°
160°
70.5
Icy Cape
Nokotlek River
CHUKCHI SEA
Avak Inlet
70°
70°
Utukok River
Kokolik River
Point Lay
none
0.01 – 0.12/km
0.13 – 0.24/km
0,25 – 0.36/km
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Kukpowruk River
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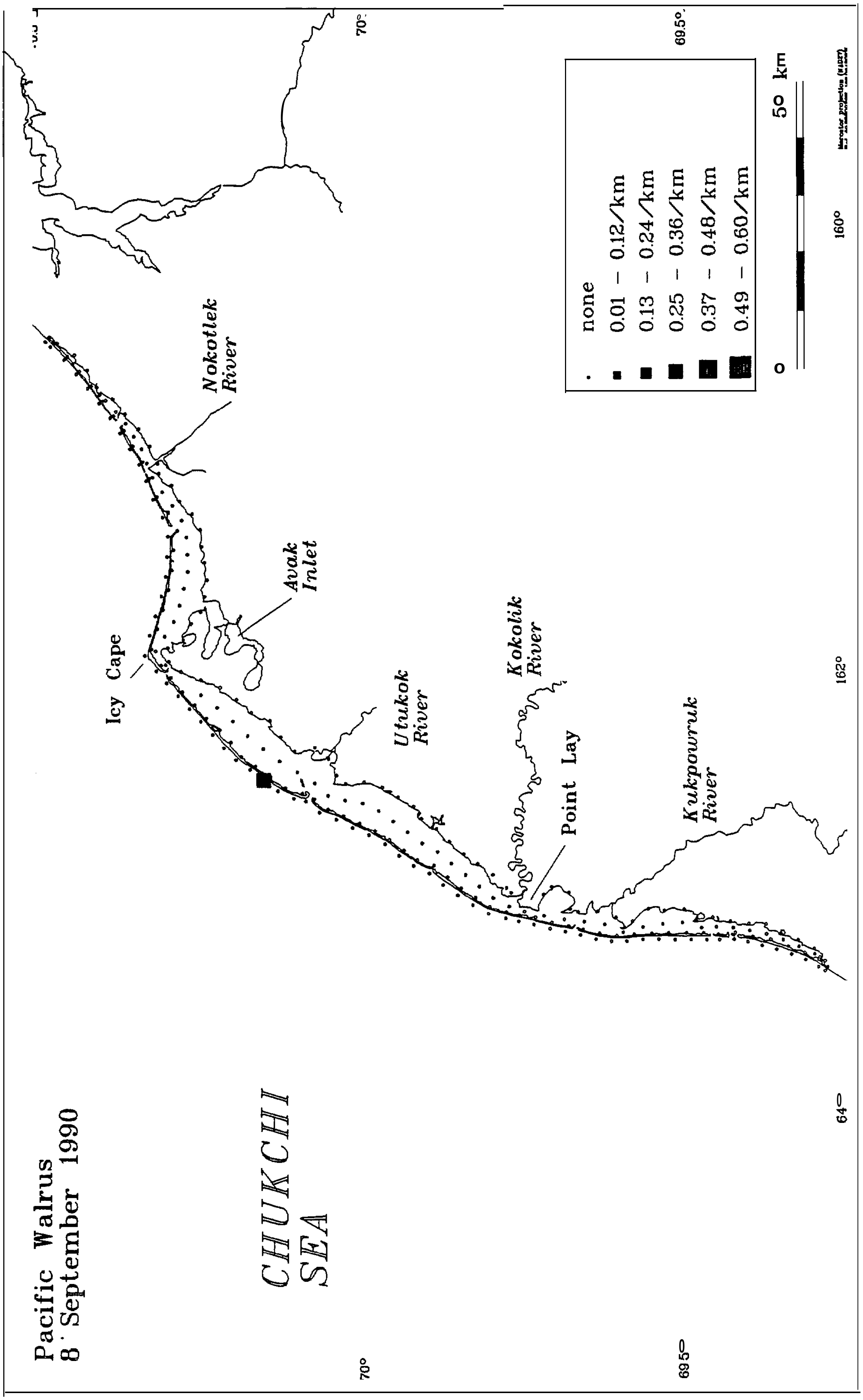
Pacific Walrus
8 September 1990
CHUKCHI
SEA
Icy Cape
Nokotlek
River
Avak
Inlet
Utukok
River
Kokolik
River
Point Lay
Kukpowruk
River
none
0.01 – 0.12/km
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50 km
70°
69.5°
164°
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PART I

PART II

USE OF KASEGALUK LAGOON BY MARINE MAMMALS

Draft Report of 1989-1990 Studies

by

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381 Elden St., MS635, Herndon, VA 22070-4817

March 1991

This study was funded by the Alaska Outer Continental Shelf Region of the Minerals Management Service, U. S. Dept. of the Interior, Anchorage, Alaska under contract number 14-354002-30491.

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ABSTRACT

This report describes the distribution, relative abundance, and habitat use of spotted seals (Phoca largha) and beluga whales (Delphinapterus leucas) in the Kasegaluk Lagoon region of the Chukchi Sea. Data from previous studies are reviewed and results from surveys conducted in 1989-90 are presented. Beluga whale surveys were flown on 12 consecutive days from July 3-14, 1990. Belugas where seen during every flight with numbers ranging from 31 to 1200. The largest sightings were on July 3-6, when a group of 800-1200 was seen in the southern portion of the study area, off Omalik Lagoon. After July 6, the number of belugas seen near Omalik Lagoon decreased markedly, and whales began to appear at passes along Kasegaluk Lagoon. They were first seen at the southernmost passes, and later to the north of Point Lay. From July 7-14 a maximum of 242 belugas was seen on any one day. No surveys were conducted from July 15-25. No belugas were seen on periodic spotted seal surveys after July 25. The beluga harvest in Point Lay usually occurs in early July. Since 1977 the average annual harvest has been 22, with a range of O-64. The average harvest has increased as follows: 10 for the period 1977-1980; 19 for 1981-1985; and 35 for 1986-1990. Stomachs of belugas harvested by Point Lay hunters were all empty in 3 of the 4 years since 1987, probably because of the long drives that preceded the hunts. In 1988, 11 of21 stomachs had measurable contents which consisted almost entirely of crangonid shrimps and echiuroid worms. These prey indicated that belugas were feeding on the bottom. The reasons why belugas concentrate near Kasegaluk Lagoon are unknown, but may include calving, molting, and/or feeding. Births and females with neonate calves have been observed in the large concentration ofbelugas that occurs in the region. Large gravel beds are located off southern Kasegaluk Lagoon, and belugas may go to those areas to rub off loose skin during the molting process. Some feeding occurs near Kasegaluk Lagoon, as demonstrated by the presence of food in the stomachs of harvested whales and reports from hunters. However, the importance of this region for feeding is unknown. Based on fisheries studies and local residents there is no indication that nearshore food resources are so abundant or suitable that they would attract and feed over 1,000 belugas for several weeks. Most suitable species of forage fishes are not abundant until after the belugas have gone. Spotted seal surveys were flown during two periods in 1989 (August 23-38 and September 11-14) and four periods in 1990 (July 26-28, August 11-13, August 21-26, and September 8-12). Seals were observed hauled out at three general locations: Utukok Pass and associated shoals; Akoliakatat Pass and the spits to the east and west; and Avak Inlet on spits within the Inlet. No seals were seen hauled out during the July 3-14, 1990 beluga surveys. By late July, 500-2000 seals were hauled out, primarily at Utukok Pass. In 1990 use of Utukok Pass was greatest in late July and early August, decreased markedly in late August, and increased again in early September. Late August and September 1989 surveys suggested the same trend. Over 400 seals were reported hauled out at Utukok Pass in early October 1989, well after our surveys had ended. At Akoliakatat Pass in 1989 the highest numbers of seals counted on the three haulout sites combined were 740 on August 26 and over 900 on September 1. In 1990 few seals (less than 250) were counted at Akoliakatat Pass until the third week in August. From then until mid-September there were usually 500-1500 seals hauled out. In Avak Inlet the maximum number of seals counted at the four haulout sites was 530 on August 26, 1989 and 532 on August 25, 1990. In 1990 use of this area was greater in late August than in either July or September.

These three locations in Kasegaluk Lagoon are the largest systematically documented and verified spotted seal haulouts in Alaska, with 1,800-2,100 seals counted in the area in July-September 1989 and 1990. Available reports from 1974-1981 suggest that a similar number of seals used the area 10-15 years ago. Only three other areas in Alaska are reported to have 1,000 or more spotted seals hauled out (Kuskokwim River mouth, Scammon Bay, and Cape Espenberg); those sightings are more than 10 years old, and none of the numbers have been from verifiable surveys or photographs. While there is little direct information available on spotted seal feeding in or near Kasegaluk Lagoon, it is likely that seals concentrate thereto feed. They arrive in late July, following a period of reduced food intake during the April-June molt. During this time metabolic rates increase significantly and the seals gain weight. A compilation of stomach contents data from 62 spotted seals collected along the Bering and Chukchi Sea coasts in summer-autumn 1966-1987 indicates that the most commonly eaten foods are herring, saffron cod, arctic cod, sculpins, smelt, flatfish, and capelin. All these types of fishes are present inside or offshore of Kasegaluk Lagoon. The species most likely to be used as food by spotted seals in this area are herring, capelin, smelt, and arctic cod. Calculations based on energetic studies suggest that spotted seals hauled out at Kasegaluk Lagoon consume at least 3,570 kg of food per day, which is over 400,000 kg of food in a four month period. The spotted seals at Kasegaluk Lagoon are the most wary of any seals that we have studied. As aircraft approached at altitudes of up to 914 m and distances of 1-2 km, seals sometimes left the haulouts and went into the water. At altitudes below 500 m it was almost impossible to fly over a large group without causing some or all of them to go into the water. However, seals generally hauled back out relatively quickly after being disturbed which may be an accommodation to the frequent aircraft traffic in the area. At this point, one complete season of surveys has been conducted for belugas and spotted seals, and another partial season for seals only. While aerial surveys have confirmed that Kasegaluk Lagoon is one of the most important concentration areas for spotted seals in Alaska, they do not provide information on why the area is important, or on specific aspects of haulout behavior, movements, and feeding.

ACKNOWLEDGEMENTS

Without the cooperation, advice, and assistance of the people of Point Lay this study would not have been possible. We especially thank Warren Neakok who shared his knowledge of spotted seals and belugas with us, often flew with us, and provided us with transportation to and from the aircraft while we were in Point Lay. We thank Amos Agnasagga for making us welcome in the community, supporting our project, and making sure we had what we needed and made contact with the appropriate people. Ben Neakok rented us his boat and acted as our guide during the spotted seal field camp. Without him, the trip would not have been possible.

We gratefully acknowledge the cooperation and assistance of the North Slope Borough. NSB Department of Wildlife Management personnel assisted with logistical arrangements, the flying of surveys, and conducting the spotted seal field camp. They shared information and samples from the Point Lay beluga harvest, without which we would have no data on the feeding of belugas in this area. The NSB Department of Public Works in Point Lay took care of offloading, storing, and moving our aircraft fuel. We particularly thank Bill Treaty who came to our aid by helping us to fix things, loaning us tools, finding us work space, and maintaining a good sense of humor through it all. His assistance was invaluable.

We thank our pilots, Tom Blaesing of Commander Northwest and Jim Helmericks of Golden Plover Air, without whom we could not have accomplished these surveys. Both went out of their ways to make this project a success. Jim Helmericks' skill as an observer was invaluable when estimating large groups of diving seals and in providing additional counts of seals during bird surveys and while transiting to and from Point Lay. Steve Johnson was our liaison with LGL and we shared many weeks in the field together. We thank him for all aspects of project management, for assisting with field observations of seals, and for making camp a more livable place.

John Burns first called our attention to the importance of Kasegaluk Lagoon to belugas and spotted seals over a decade ago. His observations laid the ground work for this study and his continued interest has helped to make others aware of the importance of this area. We are indebted to him for sharing with us information from his many years in the north.

INTRODUCTION

Beluga whales (Delphinapterus leucas) and spotted seals (Phoca largha) are seasonally the most abundant marine mammals in the Kasegaluk Lagoon region of the northeastern Chukchi Sea. They regularly use the coastal zone and lagoon waters during summer and autumn for a variety of purposes. Belugas feed, calve, and probably molt in nearshore waters. Spotted seals may feed in nearshore marine waters or on anadromous fishes in estuaries and rivers. Both belugas and spotted seals are important subsistence resources for local residents. The village of Point Lay regularly harvests belugas (Lowry et al. 1989), and in some years belugas may make up over 50% of the annual harvest of wild foods (Pedersen, in press). However, despite the large numbers of beluga whales and spotted seals using Kasegaluk Lagoon and their "importance to coastal residents, prior to 1989 there were no systematic studies of their distribution and abundance in this region.

In 1989 the Minerals Management Service (MMS) funded the Alaska Department of Fish and Game (ADF&G), under subcontract to LGL Alaska Research Associates, Inc., to investigate the use of Kasegaluk Lagoon by spotted seals and beluga whales. The completed study will include two years of beluga surveys in July 1990 and 1991, and surveys of spotted seals at intervals during 1989-1991. This is an interim report which presents the results of studies conducted in 1989 and 1990.

Background

Beluga Whales

Beluga whales are widely distributed in marine waters of western and northern Alaska, and show pronounced seasonal movements. During winter, belugas occur principally in the seasonal sea ice of the Bering Sea, although some may overwinter in the Chukchi Sea pack ice where open water in the form of leads and polynyas regularly occurs (Kleinenberg et al. 1964; Fay 1974; Seaman and Bums 1981; Ljungblad et al. 1986; Brueggeman and Grotefendt 1988). The distribution of belugas changes greatly in March and April as the sea ice cover loosens. Many whales migrate northward through leads and shear zones of the Bering, Chukchi, and

Beaufort seas. Most of these whales probably summer in the eastern Beaufort Sea, Amundsen Gulf, and the Mackenzie estuary (Fraker et al. 1978; Davis and Evans 1982). Due to ice conditions and seasonal movement patterns, this group spends little time in coastal waters of western Alaska. Other belugas migrate less extensively and appear in coastal waters of the Bering and Chukchi seas shortly after spring breakup. Concentration areas occur in Bristol Bay, Yukon Delta/Norton Sound, Kotzebue Sound, and near Kasegaluk Lagoon (Seaman et al. 1985; Frost and Lowry, in press).

Belugas begin appearing in Kotzebue Sound in early to mid-June, and are commonly seen in this region until July. In late June and July, belugas are seen along the Chukchi Sea coast northwest of Kotzebue and east of Cape Lisburne. In July large numbers appear near the barrier islands and passes off Kasegaluk Lagoon, both south and east of Icy Cape. Belugas are Occasionally reported further to the northeast, especially near Wainwright, in late July through early September (Frost et al. 1983; Seaman et al. 1985; Frost and Lowry, in press).

Coastal residents have known about and relied upon the regular seasonal appearance of belugas along the Kasegaluk Lagoon coast for as long as they have lived and hunted there (Neakok et al. 1985). The first published report of belugas in this region was by Childs (1969) who reported seeing about 50 belugas near the Pitmegea River on 24 June 1958. ADF&G began studies in the vicinity of Kasegaluk Lagoon in 1978, when observations and conversations with residents indicated that large numbers of belugas occurred in the area each year. Based on this and subsequent work a compilation of beluga sightings was prepared (Frost et al. 1983) and the use of the area by belugas was described (Seaman et al. 1985; Frost and Lowry in press).

The first estimates of the number of belugas in the Kasegaluk Lagoon region were made by Seaman et al. (1985). Aerial photographs taken in July showed a maximum of 703 whales in 1978 and 1,601 in 1979. Using various correction factors they estimated that approximately 2,300 belugas were present in 1979. Frost et al. (1983) reported a count of 670 belugas in the area in July 1981. In July 1987, Frost and Lowry (in press) counted 723 belugas west of Point Lay and estimated that this represented 1,400-2,100 whales. Another aerial survey effort in 1987 reported a maximum sighting of 500-900 whales near Omalik Lagoon in early July (Hansen 1988).

Spotted Seals

The general distribution of spotted seals, and their taxonomic status, have been discussed by Bums (1970), Fay (1974), and Shaughnessy and Fay (1977). Available information on their biology and natural history was reviewed and summarized by Quakenbush (1988). Spotted seals are closely related to Pacific harbor seals (Phoca vitulina), and may be mistaken for them in field observations. In Alaska most harbor seals use terrestrial haulouts for pupping in May-June and molting in August-September, although floating ice, particularly that from tidewater glaciers, is also used. In contrast, spotted seals are associated with sea ice from late autumn until early summer. They have their pups on the ice in late March-April and molt on the ice shortly thereafter. During spring the entire spotted seal population is found in the southern ice front of the Bering Sea, with the highest concentration within 25 km of the southern edge (Bums 1970; Bums et al. 1981). As the ice disintegrates and recedes north, spotted seals move northward and towards the coast. During summer they are especially common in bays, estuaries, and the mouths of major rivers along the coasts of the Bering and Chukchi seas. Like harbor seals, they sometimes haul out on land at this time, particularly on sandy beaches, spits, and barrier islands. As the ocean begins to freeze in autumn and early winter, spotted seals move away from the coast and southward toward the ice front in the Bering Sea.

Systematic attempts to survey spotted seals have occurred in spring in the Bering Sea ice front (Bums and Harbo 1977; Braham et al. 1984; ADF&G unpublished data). While these surveys identified apparent concentration areas and gave an indication of overall abundance, they provided no information about distribution or abundance at other times of years or in particular areas. Frost et al. (1982, 1983) compiled all sightings of marine mammals in the coastal zone of the eastern Bering and Chukchi seas during summer and autumn available through 1982, and identified areas of particular importance to the various species. Based on information from local informants and opportunistic sightings, they determined that major spotted seal haulouts within Kasegaluk Lagoon were among the largest concentrations in Alaska. While seals were present throughout the Lagoon and hauled out at a variety of locations, the barrier island sandbars and spits adjacent to Utukok and Akoliakatat passes had by far the largest reported sightings, with up to 1000 seals reported at each location. Apparently, there was no information collected on spotted seals in the Kasegaluk Lagoon region during the period from 1983 through 1988, In areas of Alaska such as Bristol and Nanvak bays, the behavior of spotted seals during summer and early autumn may be quite similar to that of harbor seals. Both species congregate near areas where there are predictable runs of anadromous fishes, and haul out on nearby beaches, sandbars, and spits. At Nanvak Bay where both spotted seals and harbor seals haul out, Johnson (1975) noted that the two species hauled out on separate parts of the beach, but there were no major differences in their behavior.

In Alaska harbor seals are generally found year round in areas with large tidal range, and their haulout behavior is known to correlate with tidal stage and time of day (Pitcher and Calkins 1979). In areas where adequate substrate for hauling out is available at all stages of the tide, a diurnal pattern may dominate (Stewart 1984). There is no information to indicate what factors may affect hauling out patterns of spotted seals. Tide should not have any influence on the behavior of spotted seals when they are associated with sea ice, and it is generally thought that peak numbers are hauled out at mid-day as is the case with ringed seals (Phoca hispida) (Frost et al. 1988). In most areas of northern Alaska where spotted seals are common in summer, the daily tidal range is small and is frequently masked by wind and wave action. Also, there is little diurnal change in light or temperature during mid-summer months. Thus, there is no information available with which to determine the best time of day or conditions in which to fly summer surveys of spotted seals, or to evaluate the possible sources of variability in counts.

Objectives

The general objective of this study is to compile historical data and gather additional data and use it to describe the distribution, relative abundance, and habitat use of beluga whales and spotted seals in the Kasegaluk Lagoon area. Specific objectives were as follows:

Beluga Whales

1. Determine distribution and relative abundance of beluga whales in Kasegaluk Lagoon and adjacent marine waters during two open water seasons by conducting replicate aerial surveys of the nearshore zone.

Spotted Seals

1. Determine distribution, relative abundance, and habitat use of spotted seals in Kasegaluk Lagoon during two open water seasons.
2. Describe haulout behavior of spotted seals in Kasegaluk Lagoon relative to time of day, water level, and weather in order to determine the best time to conduct aerial surveys.
3. Obtain opportunistic information on feeding of spotted seals in and near Kasegaluk Lagoon, based on samples obtained from subsistence hunters.

STUDY AREA

Kasegaluk Lagoon is a long, shallow lagoon extending from approximately 69°16'N 163°17'W north and east to 70°28'N 160°30'W (Figure 1). The lagoon is approximately 170 km in total length; 120 km from the southeasternmost end to Icy Cape, and 50 km from Icy Cape to the northeast end. It is 6 km across at its widest point. Although there are few soundings, maximum depth is probably less than 4 m with much of the lagoon 1-2 m deep. The southern end of the lagoon, from Naokok Pass south, is extremely shallow and may be covered by only a few centimeters of water. The deepest water is found at the northern end of the lagoon, and east of Icy Cape. Off shore of the barrier islands the bottom slopes gently to a depth of 10 m approximately 2 km offshore. There are extensive gravel beds near shore between Point Lay and Point Hope and between Icy Cape and Wainwright (Lewbel 1984).

The lagoon is separated from the ocean by low, narrow, sandy barrier islands which are interrupted by a series of passes. Major passes from south to north, as indicated on most maps and charts are: an unnamed double pass (called First Pass in the report), Naokok, Kukpowruk, unnamed pass across from the village of Point Lay (Point Lay Pass), Akunik, Utukok, unnamed double pass (Twin Pass), Icy Cape, Akoliakatat, unnamed pass near Nokotlek Point, and Pingorarok (Figure 1). East of Icy Cape there is a large inlet with a series of restrictions giving it the appearance of a lagoon within a lagoon; it is given the Inupiat name of Avak which means "again". At each of the constrictions there are sandy spits where spotted seal sometimes haul out.

Tidal influence in the Kasegaluk Lagoon region is minor, with daily tidal fluctuations less than 15 cm. During summer water level in the lagoon is greatly influenced by wind, with onshore, westerly winds creating high water and offshore, easterly winds creating low water. When the wind causes the lagoon to empty, muddy plumes of lagoon water can be seen extending north or south of the passes depending on wind direction, and the water remaining in the lagoon is warm with low salinity. In contrast, onshore winds cause plumes of clear, cold, high-salinity marine water to flow into the lagoon through the passes. Changing water level greatly affects the availability of spits and shoals where spotted seals haul out. In particular, the large shoal in the lagoon near Utukok Pass, spits east and west of Akoliakatat Pass, and several spits in Avak Inlet maybe exposed and provide extensive substrate for hauling out, or they may be so covered by water that they are completely undetectable from the air. Water level may change considerably in just a few hours.

Kasegaluk Lagoon is ice covered for much of the year. The lagoon freezes in early November, and the adjacent ocean freezes slightly later. Breakup occurs in late May or early June. Some ice may be present until July, particularly near and east of Icy Cape where it can become grounded on extensive, shallow shoals.

Relatively little is known about the invertebrate and fish fauna in and offshore of Kasegaluk Lagoon. Residents of Point Lay report catching pink (Oncorhynchus gorbuscha) and chum (O. keta) salmon, cisco (Coregonus spp.), arctic char (Salvelinus alpinus), smelt (Osmerus mordax), Pacific herring (Clupea harengus), and arctic flounder (Liopsetta glacialis). Studies conducted by LGL in 1982-83 indicated that marine fish species were more abundant than anadromous species in the Point Lay region (Craig and Schmidt 1985; Fechhelm et al. 1984). The most numerous marine species were herring, arctic cod (Boreogadus saida), fourhorn sculpin (Myoxocephalus quadricornis), and arctic flounder. Capelin (Mallotus villosus) and saffron cod (Eleginus gracilis) were less common. Smelt and pink salmon were the most numerous anadramous species, with chum salmon, arctic char, and arctic cisco (Coregonus autumnalis) also present.

Study Area 8

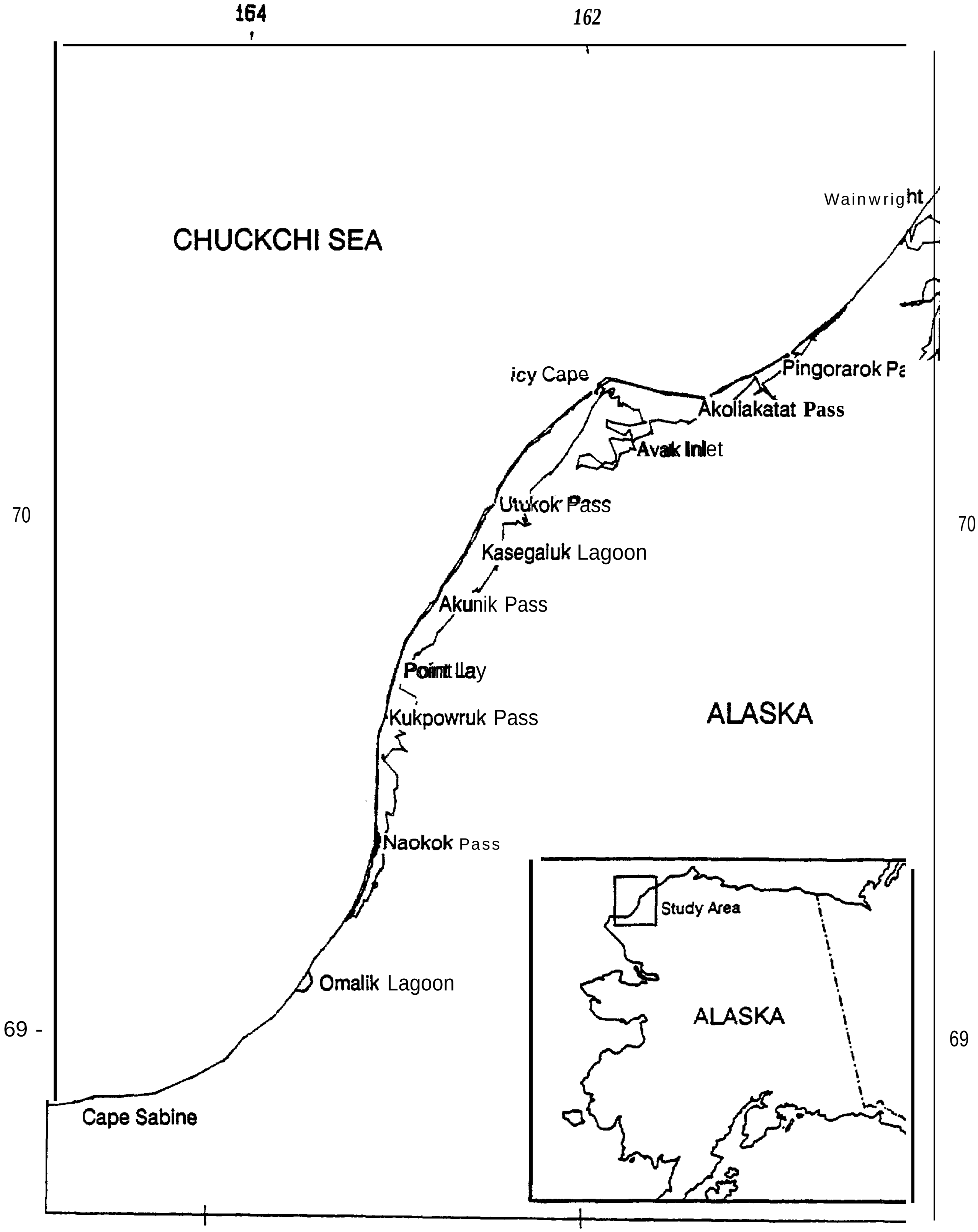

Figure 1. Map of the Kasegaluk Lagoon region.

METHODS

Aerial Surveys

Beluga Whales

Aerial surveys for belugas were conducted from July 3-14, 1990 using a high-wing twin-engine Aero Commander Shrike, capable of seating the pilot and 5 others. During surveys one person sat in the right front seat and acted as an observer and navigator. The other observer sat directly behind the pilot on the left side. Lateral visibility was excellent.

Surveys were conducted at 305 m altitude and a ground speed of approximately 220 km/hr. Slower speeds and higher altitudes were sometimes used when counting and photographing concentrations of whales.

A combination of pre-selected transects (Figure 2) and search surveys was used to provide the best possible coverage of the area between Barrow and Cape Sabine. During transit between Barrow and the north end of Kasegaluk Lagoon, flights were generally straight lines connecting points somewhat off shore from major coastal features. From the north end of the Lagoon to the mouth of the Pitmegea River the flight track followed the coastline, 0.9 km offshore. At the Pitmegea River, the aircraft turned and returned north and east flying along a series of transects that were about 5-9 km offshore. Additional transect lines were sometimes flown to expand the area of coverage or to make repeat counts.

Each observer looked for and counted belugas within a strip extending out 0.9 km from each side of the flight line. If conditions permitted (i.e., calm with no whitecaps) observers scanned a larger area. Whenever belugas were encountered, all animals, including those partially submerged but visible, were counted. If the group exceeded approximately 50 animals the aircraft circled one or more times to allow additional counts. At the time belugas were counted, their direction of travel (if any) and position relative to lagoon passes, plumes of lagoon water, and sea ice were noted. Weather, sea state, and other marine mammals seen were recorded.

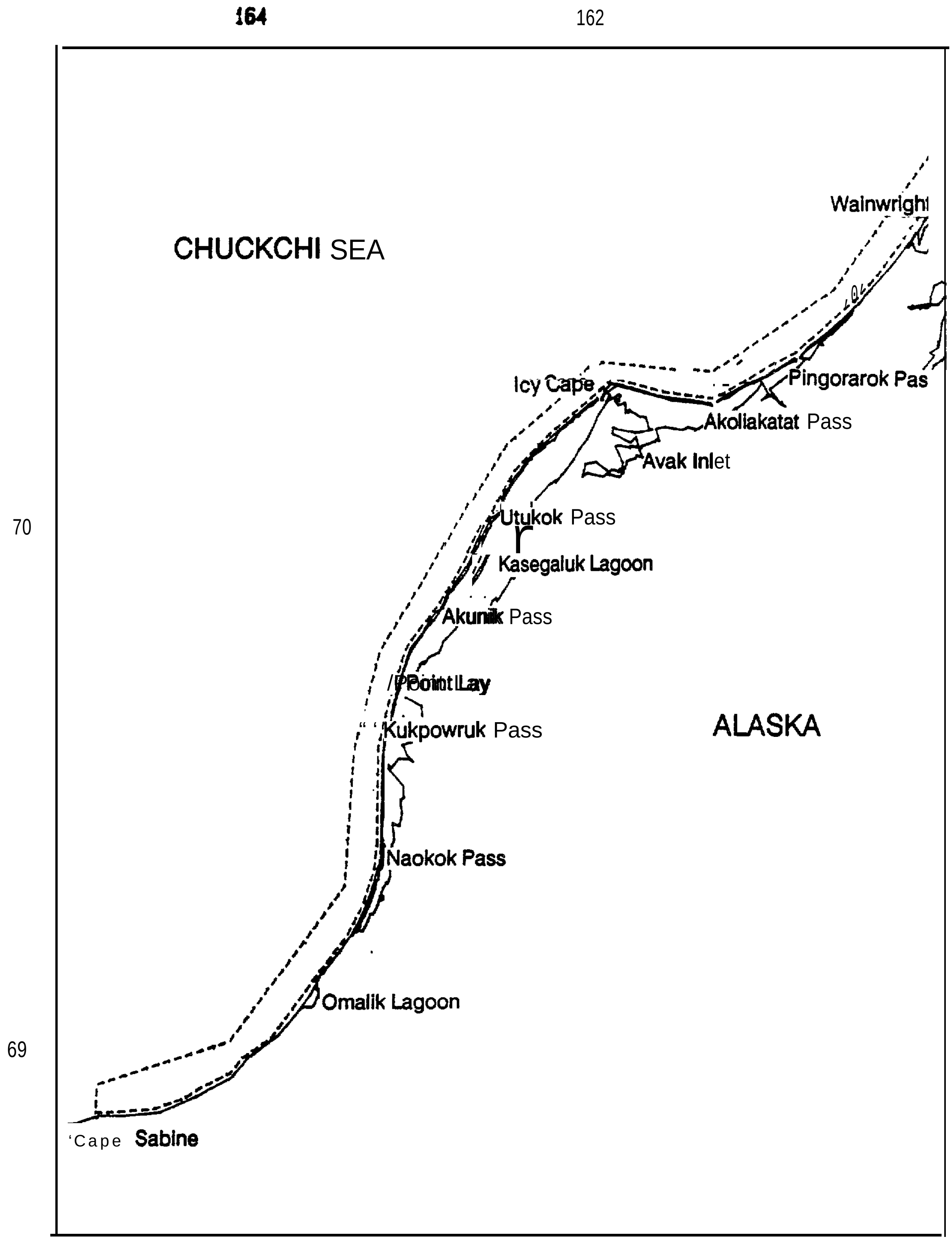

Figure 2. Map of the study area showing transect lines flown during July 1990 aerial surveys for beluga whales.

When animals were sufficiently concentrated they were photographed using a fully automatic 35 mm camera with an 80 to 210 mm zoom lens. Color slide film of ASA 64, 200, and 400 was used. Photographs were developed and counted by projecting them on a white paper screen and marking each animal as it was counted. Overlap of slides was determined by examining coastal features or the positioning of whales.

Transect widths were measured by inclinometer and indicated by marks on the aircraft windows. Locations of whales and transect waypoints were determined by LORAN and reference to known coastal features. The aircraft was equipped with extended range LORAN that incorporated a microprocessor chip for the new test station at Port Clarence, Alaska. The LORAN was initialized at takeoff in Barrow and as necessary at other known geographic locations during the flight. Accuracy was usually within 0.2-0.9 km at known landmarks.

Spotted Seals

Aerial surveys for spotted seals were conducted from a Cessna 206 on floats. A single observer sat in the right front seat. The aircraft flew around Kasegaluk Lagoon approximately 0.5 km off shore with the observer facing the barrier islands and passes. Altitude varied depending on weather and sighting conditions but was usually 305 m in 1989 and 914 m in 1990.

The observer recorded temperature, cloud cover, wind, and water level. Visual counts of seals were made with the aid of 7 power binoculars while the aircraft circled each haulout. Photographs were taken of any large groups using a fully automatic 35 mm camera, 210 mm telephoto lens, and ASA 100 or 400 color slide film. Photographs of seals were counted by projecting them onto a gridded white paper screen. Each seal was marked as it was counted to avoid duplication. Some photographs were taken using ASA 400 black and white T-max film. Negatives were enlarged to 20X 25 cm, and counts were made from prints.

Several seven-day survey periods were selected in order to give temporal coverage of most of the open water season when spotted seal were expected to be in the area. Surveys were flown on as many days as possible within each survey period. Due to weather conditions, the number of days flown within a period ranged from 3 to 5. Multiple surveys (up to four) were sometimes conducted on a single day.

During bird surveys conducted by LGL as part of this overall project, all observations of seals were also noted and estimates were made of the number of animals present. For bird surveys the aircraft flew at 45 m altitude along transects that were 200 m seaward and shoreward of the barrier islands and down the center of the lagoon. One observer was seated on each side of the aircraft. Known spotted seal haulouts were also checked during beluga whale surveys,

Harvest Studies

Each year since 1987 the North Slope Borough Department of Wildlife Management (NSB) has conducted a beluga whale harvest monitoring program at Point Lay. As part of this program, NSB biologists determine the number of belugas harvested and obtain samples of stomach contents, reproductive tracts, and teeth. Skin samples for use in DNA analysis have also been collected. Analysis of stomach contents has been done cooperatively by personnel from the NSB and ADF&G according to the methodology described in Seaman et al. (1982). The data obtained have been made available for inclusion in this report.

Spotted seal hunting occurs sporadically during the open water season. We attempted to collect stomachs from harvested spotted seals. Posters and other announcements were used to request that hunters provide us with stomachs and collection data (date and location where the seal was shot).

Haulout Behavior

A field camp was established during August 26-29, 1990 at a location about 9 km southwest of the DEW Line tower at Icy Cape. Observers camped on the beach and hiked overland about 9 km to Avak Inlet. Visual counts and observations of the response of seals to aircraft were made at two locations in Avak Inlet. Personnel also conducted reconnaissance for possible future seal observations at Utukok Pass.

RESULTS

Aerial Surveys

Beluga Whales

Surveys were flown on 12 consecutive days from July 3 through July 14, 1990. Belugas were seen during every flight with numbers ranging from 31 to 1200 (Table 1, Appendix A). Most of the numbers in Table 1 are based on multiple counts by observers. Several passes were usually made parallel to each group of whales, and counts were made by both left and right observers. Agreement between observers was very good; for example, on July 3 counts were 1109 and 1120, and on July 4 they were 1102 and 1100. Photographs were taken on some days for comparison with observer counts. The maximum number of belugas counted from photographs was 1102 on July 5. Counts from photographs were usually lower than those by observers. This is due in large part to the fact that photographs present an instantaneous view whereas observers may have an area in view for 5-10 seconds. An observer is therefore more likely to count whales that are diving and resurfacing. As an example, the visual count on July 5 was 1200, which compares to counts from slides taken on 3 separate photographic passes of 683, 861, and 1102.

The largest sightings during the survey were on July 3-6, when a single large group of 800-1200 was seen at the south end of the study area, off Omalik Lagoon (Figure 3). During this period only one other small group of 14 belugas was seen about 23 km west of Point Lay. On July 7 the group of whales near shore to the south of Kasegaluk Lagoon decreased markedly in size, and from then until July 11 the number of whales seen in this area ranged from 14 to about 180. At the same time belugas began to appear at Kasegaluk Lagoon passes. The frost sighting was of 70 animals off Naokok Pass on July 7, with subsequent sightings of up to 185 animals made at Kukpowruk, Akunik, and Utukok passes (Table 1). On July 12-14, the only belugas seen were north of Point Lay; none were seen off the southern portion of Kasegaluk Lagoon, or in the region along the coast south to the Pitmegea River.

Table 1. Numbers of beluga whales seen on aerial surveys in the Kasegaluk Lagoon region, July 3-14, 1990. All locations were surveyed on each flight unless indicated by ns. Location are shown in figure 3.

	July											
Location	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Pitmegea River	0	0	0	0	0	0	0	0	0	ns	0	0
Cape Beaufort	0	0	0	0	0	0	31	44	0	0	0	0
Omal ik Lagoon	1120	1140	1200	830	111	14	0	149	180	0	0	0
Naokok Pass	0	0	0	0	70	81	0	0	0	0	0	0
Kukpowruk Pass	**0**	**0**	**0**	**0**	**0**	**77**	**0**	**0**	**0**	**0**	**0**	**0**
Akunik Pass	0	0	0	0	0	0	0	0	0	0	2	161
Utukok Pass	0	0	0	0	0	0	0	0	0	100	185	0
Akol iakatat Pass	0	0	0	ns	0	0	0	0	0	0	0	0
Nokotlek Pass	C	0	0	ns	0	0	0	0	0	0	0	0
Pingororak Pass	0	0	0	ns	0	0	0	0	0	0	0	0
Offshore transects	ns	0	12	0	ns	13	0	19	62	0	28	ns
TOTAL	1120	1140	1212	830	181	185	31	212	242	100	213	161

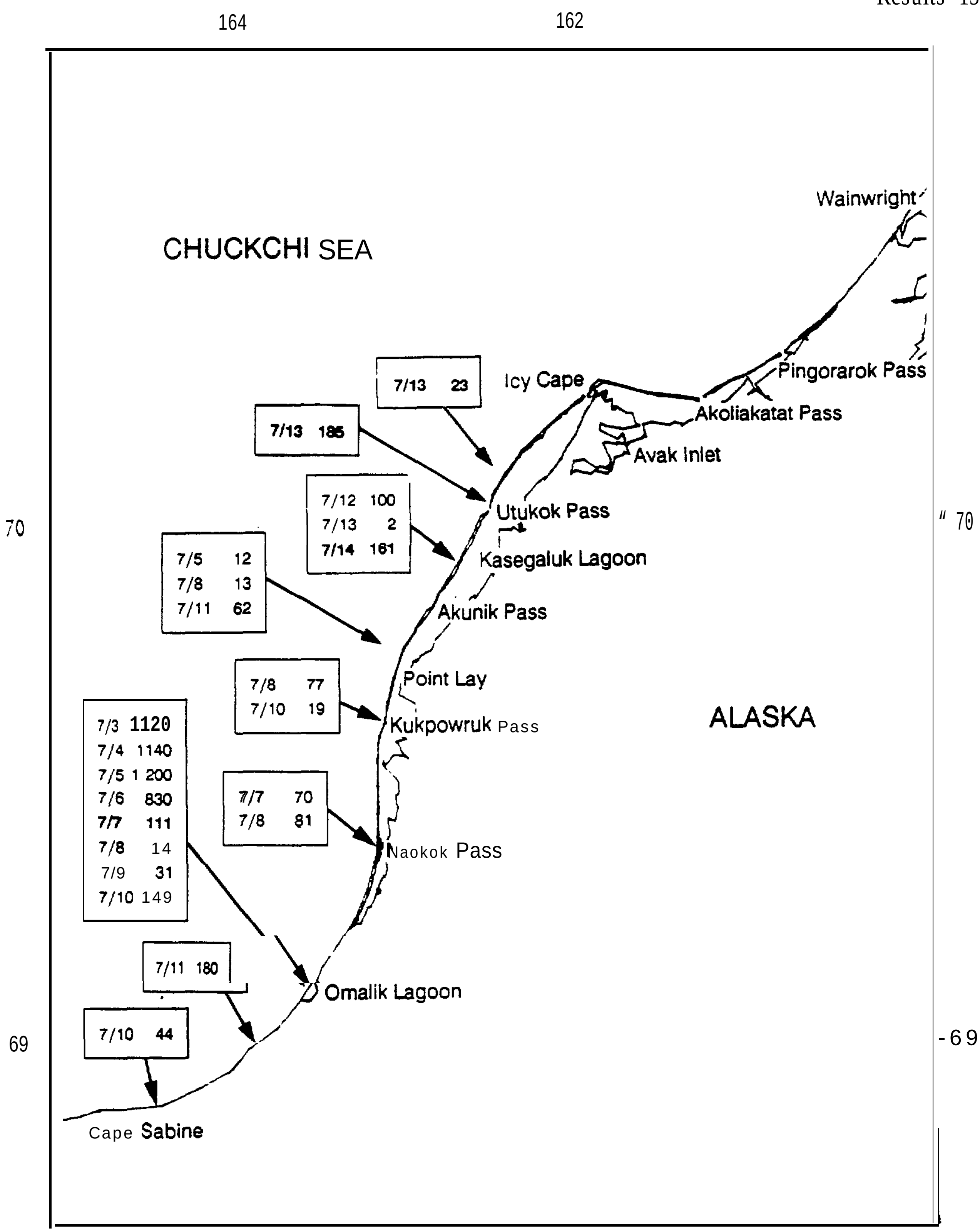

Figure 3. Sightings **of beluga** whales made during July 1990 aerial surveys.

It appears that many of the belugas that left the Omalik Lagoon region on July 6-7 were not resighted in the study area. Small groups of belugas were occasionally sighted on the standard offshore transects, but no large concentrations were located (Table 1). On July 10 we saw a group of 19 belugas on the transect offshore from Kukpowruk Pass. Since it was a day with excellent weather and visibility, we flew about 180 km of additional transects extending as much as 36 km offshore, but we did not locate any more belugas.

No surveys were flown from July 15-25. Periodic spotted seal surveys commenced on July 26 and the lagoon and passes were searched for belugas, but none were seen on any of the flights.

s potted Seals

Surveys for spotted seals were flown between Naokok Pass at the south end of Kasegaluk Lagoon and Pingorarok Pass at the northeast end. In 1989 survey periods were August 23-28 and September 11-14 ('Table 2). In 1990 surveys were conducted during July 26-28, August 11-13, August 21-26, and September 8-12 (Table 3). Additional information was collected during beluga whale and bird surveys.

Hauled out spotted seals were very sensitive to disturbance. Frequently they responded to the approaching aircraft at a distance of 1 km or more, even when the plane was flying at an altitude of 760 m. As a result, in some instances the number of seals that were hauled out was estimated as the plane approached and that estimate was supplemented with subsequent counts of animals in the water near the haulout site. When conditions allowed flying at a 914 m altitude, the seals usually remained on the haulout and it was possible to circle them for counting and photographing.

In 1989 surveys began part way through the open water season, and there were seals hauling out in Kasegaluk Lagoon when the first survey was flown on August 23 (Table 2). During beluga surveys conducted July 3-14, 1990 there was still ice near shore, especially north and east of Icy Cape. There were no spotted seals hauled out at any of the Lagoon passes, but groups of up to 20 seals were commonly seen in the water, especially on offshore transects. When the first spotted seal surveys were flown on July 26, 1990 there were seals hauled out in the Lagoon (Table 3).

Table 2. Numbers of spotted seals hauled out in the Kasegaluk Lagoon study area during August-September 1989. All locations were surveyed on each flight unless indicated by ns. **Repeat** counts made on the same date are indicated by letters. Locations are shown in figures 4-6.

		Akoliatatat			Avak Inlet			
Date	Utukok	West	Pass	East	#1	#2	#3	#4
Aug 23	50-100	0	0	0	150	70	8	0
Aug 24	80	75	38	1	ns	ns	ns	ns
Aug 26a	±175	90	6	>250	0	30	500	0
Aug 26b	75	40	0	700	ns	ns	ns	ns
Aug 27a	120	0	25	10	0	0	1	0
Aug 27b	145	75	50	10	0	5	0	0
Aug 28	290	10	0	1	0	2	20	0
Sep 1	845-895	>350	0	550	0	15	20	0
Sep 3	305	0	0	117	ns	ns	ns	ns
Sep 8	300	0	0	0	0	0	55	100
Sep 11	600-700	25	2	18	6	28	190	35
Sep 13	500-600	0	0	2	0	75	85	30
Sep 14	700-750	35	0	3	0	120	>250	0

Table 3. Numbers of spotted seals hauled out in the Kasegaluk Lagoon study area during July-September, 1990. All locations were surveyed on each flight unless indicated by ns. Repeat counts made on the same date are indicated by letters. Locations are shown in figures 4-6.

Date	Utukok	Akoliatatat West	Akoliatatat Pass	Akoliatatat East	Avak Inlet #1	Avak Inlet #2	Avak Inlet #3	Avak Inlet #4
July 26	330-430	20	0	0	0	>140	±30	0
July 27	380-600	45	0	0	0	60	50	0
July 28	±1800	45	0	0	0	230-250[1]	15	0
Aug 11a	±100	0	0	0	0	15-25	0	0
Aug 1 lb	>8	>215	33	0	0	ns	ns	ns
Aug 12	10	150	0	26	0	ns		ns
Aug 13	0	85-90	0	0	0	40-45	60-%	8-10
Aug 21	280-350	450-600	35-45	23-28	0	90-120	65-80	0
Aug 22a	0	300-350	30-35	0	0	ns	ns	ns
Aug 22b	0	325	125	0	0	ns	ns	ns
Aug 23a	>110	309	±550	68	0	15	420	0
Aug 23b	15	250	550	0	0	ns	ns	ns
Aug 23c	60	>130	400	6	0	ns	ns	ns
Aug 24	20-30	>15	>560	0	0	0	±340	2
Aug 25	5	±315	±740	0	0	0	532	0
Aug 26	20-30	>80	>200	0	>20	15-20	>200	0
Sep 7	±6	0	850-900	0	0	100	>50	0
Sep 8a	>10	>5	900-1000	0	0	±50	100-150	0
Sep 8b	0	0	850-900	0	0	ns	ns	ns
Sep 8c	15-20	0	750-850	0	0	ns	ns	ns
Sep 9	6	190	±1300	0	0	0	>285	0
Sep 10a	150-275	250-325	450-600	0	0	ns	ns	ns
Sep 10b	550-675	300-350	300-400	0	ns	ns	ns	ns
Sep 10c	175-200	650-700	0	0	ns	ns	ns	ns
Sep 10d	0	>170	>100	0	0	1	>175	0
Sep 1 la	0	>20	700-800	0	0	10	150-200	0
Sep 11b	25	5	550-600	0	0	12	75	0

[1] a shoal near Avak #2 was visible only on this day and 150 seals were hauled out on it

No seals were observed hauled out at the passes south of Point Lay in either 1989 or 1990, although single seals were occasionally seen in the water. No seals were seen hauled out at three of the four passes between Point Lay and Icy Cape: Akunik, Twin, and Icy Cape passes. The fourth, Utukok Pass, was used by a large number of seals in both years. The seals used several haulout locations (Figure 4). When the water level was low, a large shoal was exposed off the east end of the north side of the Pass. The largest number of seals was always on that shoal when it was exposed. Smaller groups of seals sometimes hauled out at several locations near the end of the barrier island forming the north side of the Pass. In August 1989 the number of seals seen at Utukok Pass ranged from 50-100 to 290. From September 1-14, the number ranged from 300 to 845-895. A report from a local hunter indicated that over 400 seals were hauled out at Utukok Pass in early October (A. Agnasagga, personal communication). In 1990 the maximum number of seals seen at Utukok Pass was approximately 1800 on July 28. In August the maximum count was 280-350 on August 21, with numbers usually less than 100. In September the highest count was 550-675 on September 10. Counts on the other four early September surveys were 0-20.

Of the three passes northeast of Icy Cape, seals hauled out only at Akoliakatat Pass. Long, narrow spits extend into the lagoon to the east and west of Akoliakatat Pass (Figure 5). These spits, and the spit extending off the west end of the Pass itself, were all used in both 1989 and 1990. In 1989 the largest sightings were on the spit east of Akoliakatat Pass: 700 on August 26 and 550 on September 1. The highest combined totals for all three Akoliakatat sites in 1989 were 740 on August 26 and 900 on September 1. During the earliest surveys in July 1990, very few (less than 50) seals were counted at Akoliakatat. Numbers increased in August and by the week of August 21-26 there were usually more than 500 seals on the three sites combined. Numbers remained high in September with counts ranging from 600-1490. In 1990 the largest number of seals was almost always hauled out at the spit west of Akoliakatat or at the pass itself. Seals were seen hauled out at the east spit on only three days in 1990.

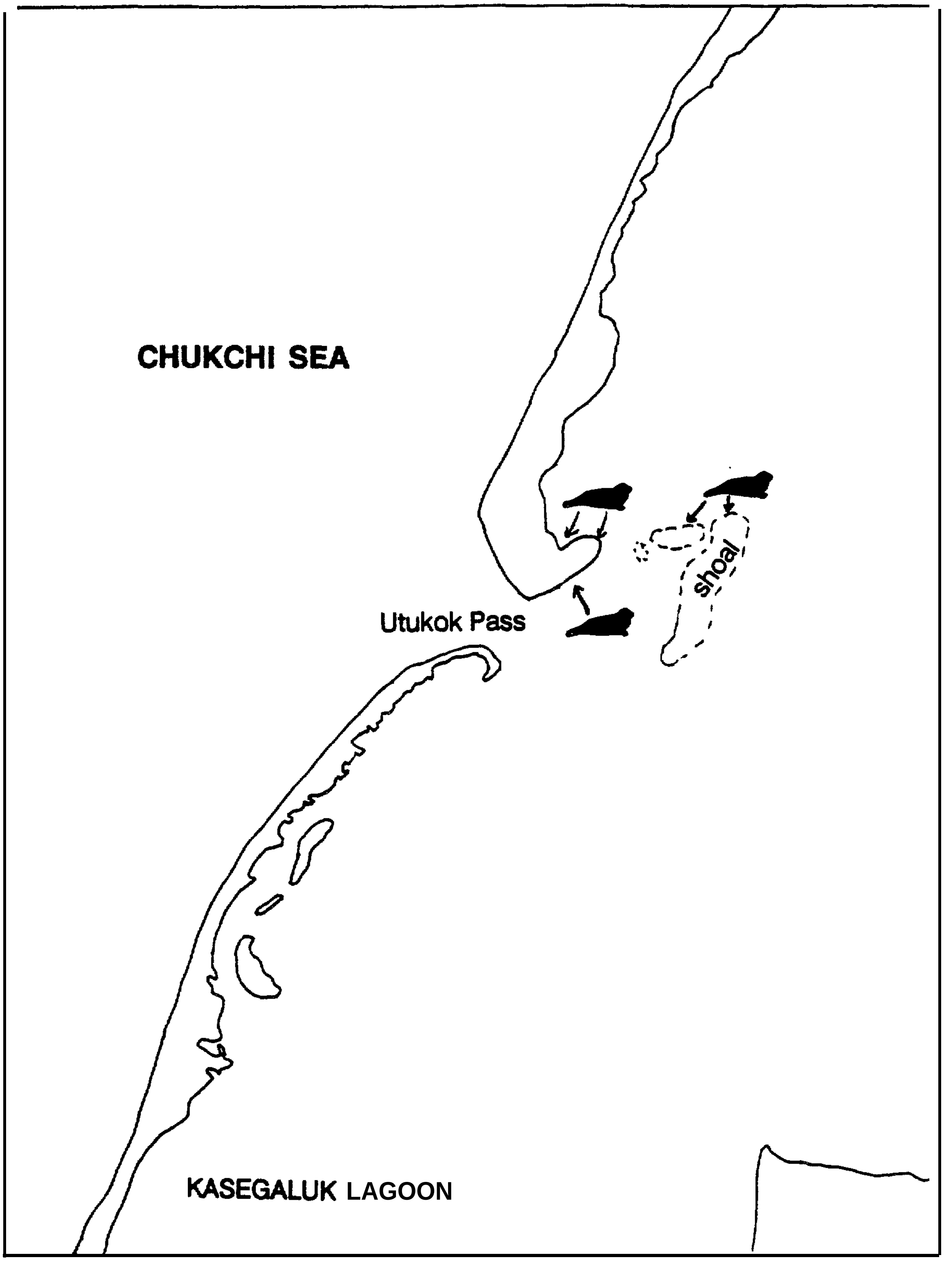

Figure 4. Map of the Utukok Pass region showing locations used by spotted seals for hauling out.

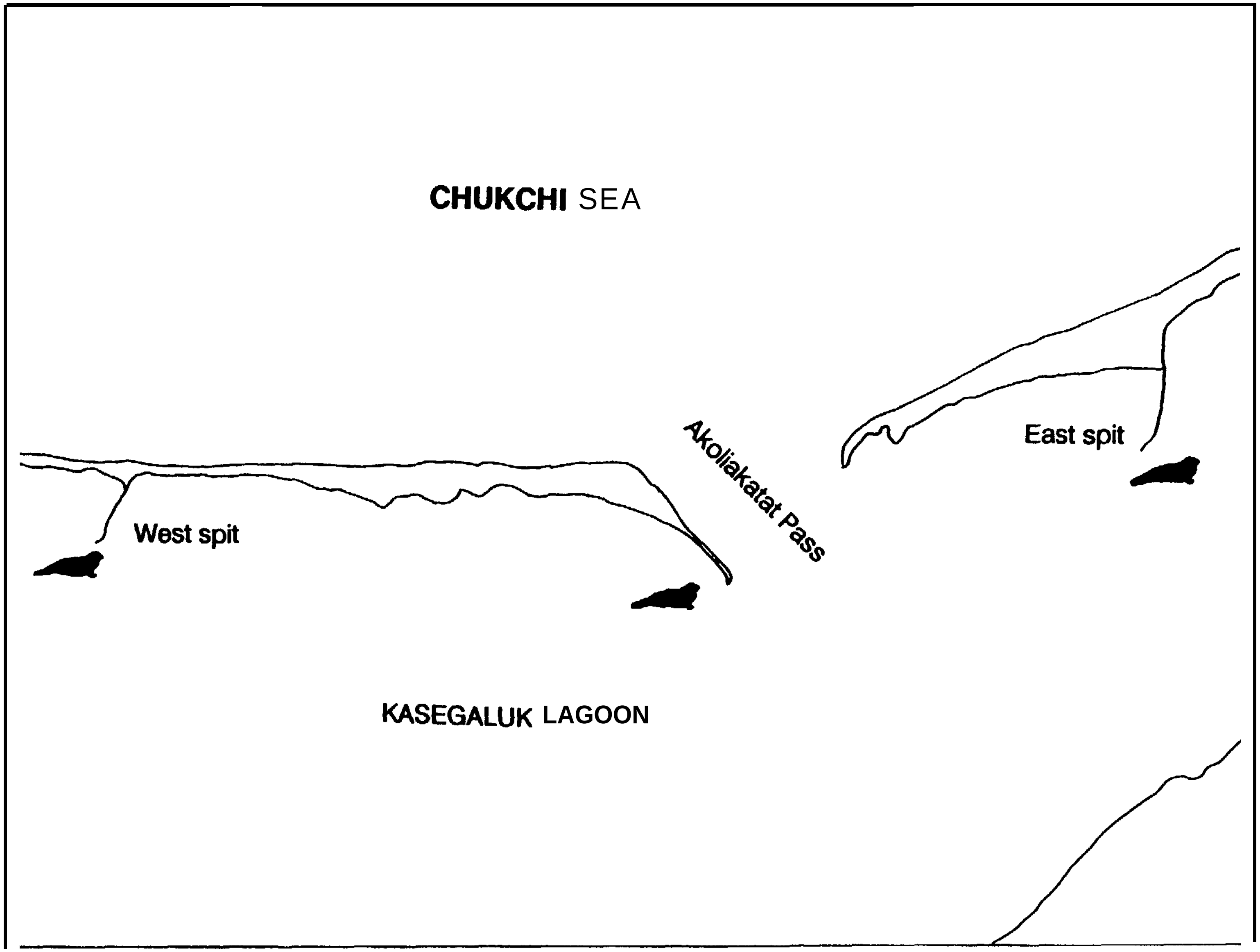

Figure 5. Map of the Akoliakatat Pass region showing locations used by spotted seals for hauling out.

Seals hauled out at four locations in Avak Inlet (Figure 6). These locations were referred to as Avak #1-#4. Avak #1 and Avak #4 were seldom used in either 1989 or 1990. The primary haulout sites were Avak #2 and Avak #3. In 1989 up to 120 seals were seen at Avak #2, and in 1990 up to 250 were counted; usually there were less than 100 seals there. Avak #3 was the major haulout, with a maximum of 500 seals counted in 1989 and 532 in 1990. In 1990 more seals hauled out at Avak Inlet sites in late August (155-532) than in July (110-265) or September (150-210).

Harvest Studies

Harvest Levels and Characteristics

The beluga harvest in Point Lay usually occurs during early July. The hunt is a communal event, in which most of the local boats are used to drive (herd) belugas to a shallow water site near the village where they are killed. The animals are processed by members of the community working together, and then stored in family ice cellars.

Since 1977 the average annual harvest of belugas by Point Lay hunters has been 22, with a range of 0-64 (Table 4). The harvest has tended to increase as the village, which was reestablished in 1972, has grown. Average harvests were 10 for the period 1977-1980, 19 for 1981-1985, and 35 for 1986-1990. The largest harvest in the 14 year period for which we have data occurred in 1990.

Foods Eaten by Marine Mammals

During 1990 we were able to examine the stomach of one spotted seal that was shot by a Point Lay hunter near Utukok Pass. The stomach was empty.

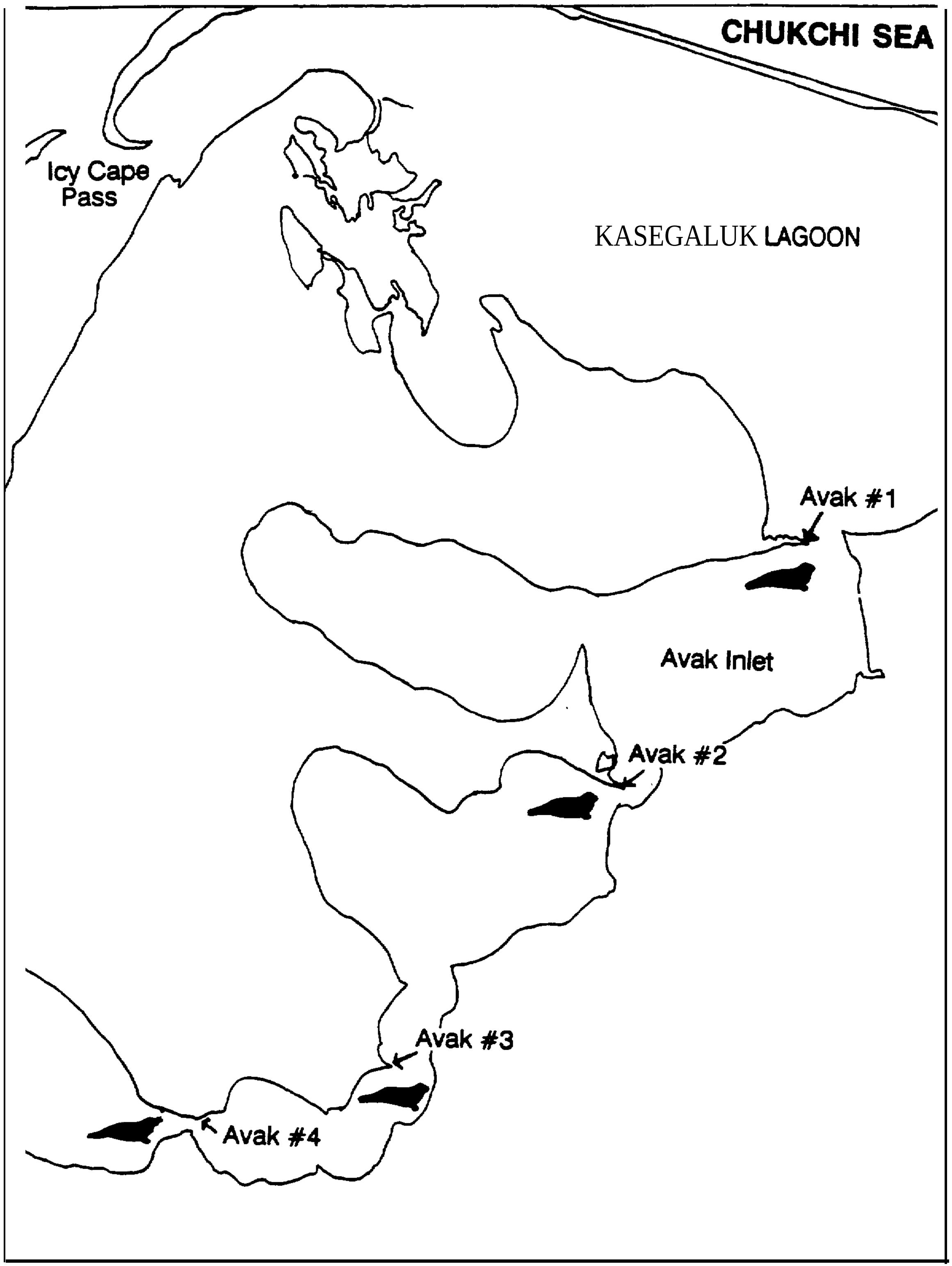

Figure 6. Map of the Avak Inlet region showing locations used by spotted seals for hauling out.

Table 4. Harvest of beluga whales at Point Lay, Alaska, 1977-1990. total number is the recorded harvest. Numbers in parentheses are estimated total harvest, not including animals that may have been struck and lost. Data are from Seaman and Bums (1981), Bums and Seaman (1986), Lowry et al. (1989), ADF&G (unpublished), and North Slope Borough Department of Wildlife Management (unpublished).

Year	Sex: Males	Sex: Females	Sex: Unknown	Total
1977	--	--	8	8
1978	8	4	1	13
1979	--	--	3	3
1980	--	--	15	15(15-18)
1981	--	--	29	29(29-38)
1982	--	--	28	28(28-33)
1983	8	10	0	18
1984	--	--	0	0(30)
1985	--	--	18	18
1986	--	--	33	33(34-37)
1987	13	6	3	22
1988	24	13	3	40
1989	3	13	0	16
1990	34	28	2	64

Since 1987 stomachs from belugas have been collected and examined by personnel from the North Slope Borough Department of Wildlife Management. Because the belugas are usually driven for several hours before they are killed, the stomachs are often empty. This was true in 1987, 1989, and 1990. In 1988 the drive was short, and 11 of 21 stomachs had measurable amounts of contents (Table 5). Ten stomachs contained remains of crangonid shrimps. Two genera were represented (Argis and Sclerocrangon) with volumes ranging from less than 1 to 750 ml. Echiuroid worms (Echiurus echiurus) were present in 7 stomachs. In five stomachs only spines were present, while the other two had 185 and 300 ml of fecal castings. One stomach had a jaw from a polychaete worm, and another had remains of a sipunculid worm. All of these prey indicate that the belugas were feeding on the bottom.

Behavior of Spotted Seals

A field camp was established during August 26-29, 1990 to observe the hauling out behavior of spotted seals. We wanted to situate the camp at Utukok Pass, where large numbers of seals are usually hauled out and available for observation. However, although hundreds of seals were present in the water, none were hauled out on our arrival, and few had been seen hauled out during the preceding 4 days (Table 3). The water was rising and the weather poor, and there was no suitable place to camp near the Utukok Pass haulout. Instead, camp was established on the mainland about 9 km south of Icy Cape. Observers had to hike about 9 km overland to Avak Inlet to get to a location where seals haul out. Observations were made on August 26. That evening and the following day, 70-90 km/hr winds precluded further observations. On August 28 the weather improved enough to allow another trip overland to Avak Inlet. On August 29 we returned to Point Lay, on the advice of our local guide and boat operator, Our return was followed by another extended period of stormy weather.

Table 5. Stomach contents of beluga whales harvested near Point Lay, Alaska, during July, 1988. Values given are volumes in milliliters; P. indicates that the item was present but no volume could be determined. Samples were collected by the North Slope Borough Department of Wildlife Management, with cooperation of Point Lay hunters, and analyzed by ADF&G.

Prey Species	Specimen Number										
	6	7	9	14	15	18	20	23	25	28	29
Family Crangonidae	750								P	70	26
<u>Argis</u> sp.			5	12	P	P	200	10			P
<u>Sclerocrangon</u> sp.				25		P					P
<u>Echiurus echiurus</u>	P			185	P	P	P	300			P
Family Sipunculidae										5	
Family Polychaeta		P									
Total Volume	750	<1	5	232	120	215	200	310	<1	75	26

On August 26, no seals were hauled out on the Avak Inlet spits, and only a few were seen in the water. On August 28, seals were observed at Avak #3 and Avak #4. Those at Avak #4 were all in the water, oriented into the current which was headed out the inlet, and possibly feeding. At Avak #3, 430 seals were hauled out in three groups on the sand spit when investigators first arrived at noon. At least 100 more were seen in the water. There was considerable exchange between the water and land, with some seals going into the water as others hauled out. Approximately one hour after observations began, a local air carrier flew overhead in a Cessna 206 at about 150 m altitude. When the aircraft was about 1.6 km away, seals began going into the water and continued to do so until none remained hauled out. They milled in the area for several minutes and then dispersed. For the remainder of the day (until 2000 hours) observers were never able to count more than 100-150 seals inthe area and no more than 30-40 hauled out. At 1420 hours, about 1 hour after the aircraft disturbance, seals began to haul out again. At 1445 a plane flew over in the clouds, audible but not visible, and 7 of the 8 seals that had hauled out returned to the water. From then until 1800, 12-31 seals were hauled out on the spit. At 1850 hours a Twin Otter flew by 2-3 km to the east at about 1500 m altitude, and 14 of31 hauled out seals went into the water. One hour later, when observations were terminated, there were 37 seals hauled out.

On the return trip to Point Lay, Utukok Pass was again investigated as a possible site for a future seal observation camp. It was apparent that there was no safe place to camp within 2 km of the Pass, and the nearest camping spot did not have a suitable view of the seal haulout. Avak Inlet provided a much better place to observe seals: the vantage point was higher and afforded a better view; observers could approach closer to the haulout; and the area is more protected from storms. However, access to Avak Inlet by boat is not practical due to unpredictable weather, shallow water, and distance from Point Lay.

During most aerial survey flights, observations were made of the response of seals to the survey aircraft (Table 6). Seals were extremely wary, often moving off the haulout into the water when the plane was 2 km away. During 1989 we began flying at 150-305 m, which is the usual range of altitudes used for seal surveys. It was immediately apparent that spotted seals went into the water much more readily than other species of seals that we have surveyed. Survey altitude was gradually increased to 610 m with no abatement of response; seals still went into the water when the aircraft was 1-2 km away. In 1990 we used a survey altitude of 914 m whenever weather permitted. On some days haulouts could be approached at 914 m and then circled by the aircraft down to about 457 m without any apparent response by the seals. On other days seals went into the water when the aircraft was at 914 m and 2 km away. At approach altitudes below 500 m, we observed a response on all but two occasions. On one of those days there was a patchy cloud layer between the plane at 427 m and the seals.

Table 6. Responses of spotted seals to aircraft flying at various altitudes near Kasegaluk Lagoon, Alaska. Unless noted, the aircraft was a Cessna 206 float plane.

Date	Location	Alt. (m)	Number of seals	Comments
8/23/89	Avak # 1	60	100-150	All went into water when plane >1 km away
	Avak #2	90	75	Went into water as plane approached
	Utukok	150	50-100	Into water when 1 km away
8/26/89	Akol. W	305	90	About 50% went into water when circled
	Utukok	305	100+	Some into water when circled
	Avak #3	365	500+	About 50% went into water when 1 km away
8/27/89	Utukok	365	120+	Into water at >1 km away
8/28/89	Utukok	610	150+	Into water at >1 km away; by 1 hour later all had hauled out again; into water again at 1 km away
7/26/90	Utukok	305	300+	Into water at about 2 km away; all hauled out again 1 hour later
	Avak #2	762	140+	Little response
	Avak #3	762	30+	Some went into water when circled
7/27/90	Utukok	914	380	Stayed hauled out as plane circled down; all went into water at 210 m
	Avak #2	427	60	No reaction; clouds below plane
	Avak #3	305	50	All went into water
8/23/90	Utukok	610	100+	Some went into water
	Akol . W	914	300+	No response; plane circled down to 457 m and all went into water
	Akol. Pass	914	550	Some went into water when circled
	Akol. E	914	68	No response
	Avak #3	914	420	Some went into water at >1 km

Table 6. (cent'd)

Date	Location	Alt.(m)	Number of seals	Comments
8/24/90	Avak #3	914	340+	Stayed hauled out until plane descended to 457 m
8/25/90	Akol. W	914	300+	Most went into water at >1 km; almost all hauled out again within 15 min.
	Akol. Pass	914	700+	No response
8/26/90	Avak #3	914	>100	All into water at 2 km
8/28/90	Avak #3	150	430+	Cessna 206 on wheels; seals began going into the water at 1.6 km away
	Avak #3	unknown	8	Plane above clouds, not visible; 7 seals went into water
	Avak #3	457	30	Twin Otter passed 2-3 km away; 50% of seals went into water
9/8/90	Akol. Pass	914	900-1000	Some into water as plane approached
	Avak #3	762	35+	Some into water at 1 km
9/9/90	Akol. Pass	762	1300	Some into water as plane approached; after that little response until circled at 457 m
	Avak #3	457	285	Some into water at 1 km
9/10/90	Akol. Pass	365	100+	Into water as approached
	Avak #3	305	75+	Into water; low clouds
9/11/90	Akol. Pass	457	600-700	Into water as approached
	Avak #3	488	150-200	Plane approached over land; seals stayed on bar long enough to count
	Akol. Pass	396	500+	No response
	Avak #3	610	25	Some into water even though plane in clouds; after first group went in, others stayed out until plane at <183 m

DISCUSSION

Beluga Whales

The reasons why belugas concentrate near Kasegaluk Lagoon are unknown. Previous investigators have suggested a variety of factors to explain concentrations of belugas in nearshore waters. One suggestion is that coastal waters are warmer which could confer a thermal advantage to neonates (e.g. Sergeant and Brodie 1969; Fraker et al. 1979). Seaman et al. (1985) found that belugas occurred most commonly in the plumes of water flowing out of Kasegaluk Lagoon where the July water temperature was as much as 20 C higher than in adjacent marine waters. Calves were sighted among groups of whales using these areas, and some calves were born in the lagoon (Seaman, personal communication). However, small calves presumed to be neonates have also been seen within groups of whales off shore and in pack ice.

It is also possible that belugas concentrate in these nearshore areas for reasons associated with their annual skin molt (Smith and Hammill in press; Frost and Lowry in press). Warmer waters may be important for rapid cell growth during the molt (Finley 1982; St. Aubin and Geraci in press). Reduced salinity, and particularly the presence of fresh water, may somehow augment the molt process. Whales seen in coastal waters of the Chukchi Sea during June-July all appear to be in pre-molt condition. Areas that are particularly used for molting have not been identified in Alaska, perhaps because the water is often muddy in areas where belugas congregate which makes behavioral observations difficult. At molting areas in Canada, belugas appear to rub on the bottom in places with coarse gravel substrates. There are extensive gravel beds near shore between Point Lay and Point Hope, especially in the Omalik Lagoon area (Lewbel 1984; Feder et al. 1989), and belugas may go to those gravel areas to rub off loose skin.

The importance of the Kasegaluk Lagoon region to belugas for feeding is unknown. Samples collected from various locations in Alaska have shown that beluga whales feed on a wide variety fishes and some invertebrates (Seaman et al. 1982; Lowry et al. 1985). According to hunters from Point Lay, some nearshore feeding does occur on sculpins, smelt, char, and probably capelin. The stomachs examined by us contained shrimp and echiuroid worms. However, there is no indication that nearshore food resources are so abundant or suitable in this area in early July that they would attract and feed over 1000 belugas for a period of several weeks. It is possible that belugas feed mostly off shore, where species such as arctic cod are relatively abundant, but we do have no direct data to support this suggestion.

Fisheries studies conducted near Point Lay indicate that herring, smelt, arctic cod, and fourhorn sculpins are the most numerous species (Craig and Schmidt 1985). Pink salmon, arctic flounder, capelin, arctic char, and cisco also occur in this area (Fechhelm et al. 1984). Peak spawning runs of smelt occur in late June, about the time belugas are first seen near Kasegaluk Lagoon. Most other species (herring, arctic cod, capelin) are not common near shore until mid- to late July or early August, after the belugas are gone.

There is little information available on epibenthic invertebrate fauna in this area. Feder et al. (1989) conducted studies of the benthos in the eastern Chukchi Sea, but did not sample the epifauna. They reported that Echiurus echiurus, one of the main items found in beluga stomachs at Point Lay, was present at a density of 83 individuals/m2 at 11 sampling locations 50-150 km west of the coast from Cape Lisbume to Icy Cape. Frost and Lowry (unpublished) conducted five otter trawls near Kasegaluk Lagoon in September 1981. Crangonid shrimps, which were also common in beluga stomachs, were among the most abundant species in trawls near Cape Sabine and Akoliakatat Pass.

Spotted Seals

Distribution and Abundance

Most of the available information pertaining to spotted seals refers to their distribution and biology during the late winter and spring when they are associated with seasonal pack ice. In the Bering Sea at this time they are concentrated in three areas: the southeastern Bering Sea, the Gulf of Anadyr, and Karaginskii Bay (Tikhomirov 1966; Shaughnessy and Fay 1977;

coast from Bristol Bay to the Beaufort Sea (Frost et al. 1982, 1983; ADF&G unpublished), and in Canada east at least to Herschel Island (Porsild 1945).

According to the data compilations by Frost et al. (1982, 1983), there are only four major haulout areas along the Alaska coast where 1,000 or more spotted seals have been seen: the mouth of the Kuskokwim River on offshore sandbars near Quinhagak (5,600-6,000 in May 1978); on sandbars in Scammon Bay (1 ,000+ in June 1978); at Cape Espenberg (1 ,000+ in late August, year unknown); and at the passes of Kasegaluk Lagoon. Kasegaluk Lagoon is the only one of these areas where, as part of this project, systematic counts have been conducted and numbers documented with photographs. Sightings reported by Frost et al. (1983) for passes at Kasegaluk Lagoon are of similar magnitude to those made in this study. In September 1974, 2,500-3,000 seals were estimated to be present at Lagoon passes. This is similar to the maximum estimates for July-September 1990 of 1,800-2,100.

Previous large sightings at Utukok Pass were of 700-900 seals in July 1978,400-500 in July 1979, 1,000 in August 1981, and 300 in September 1981. The highest counts at Utukok Pass in this study were 845-895 on September 1, 1989, and approximately 1,800 on July 28, 1990. Previous sightings at Akoliakatat Pass were of 40-100 seals in July 1978 and 1979, 1,000 in mid August 1981, and 200 in mid September 1981. During this study the highest numbers of seals were counted at Akoliakatat Pass area in late August to early September. The highest counts at the three haulout sites combined were 1,055 on August 25, 1990, and 1,490 on September 9, 1990. Previous reports indicated that about 100 seals were hauled out at Avak Inlet in July 1978 and 1979. Substantially higher numbers were counted in this study, with over 500 animals at the four haulout sites combined on August 26, 1989 and August 25, 1990.

Data collected in 1989 and especially 1990 indicate seasonal shifts in haulout use among the three general haulout areas (Figures 7 and 8). In late July, most seals were seen at Utukok Pass, with smaller numbers at Akoliakatat Pass and Avak Inlet. Fewer seals were counted at Utukok Pass in August when large numbers occurred at Akoliakatat and Avak. In September, sightings of large numbes of seals occurred at all three areas.

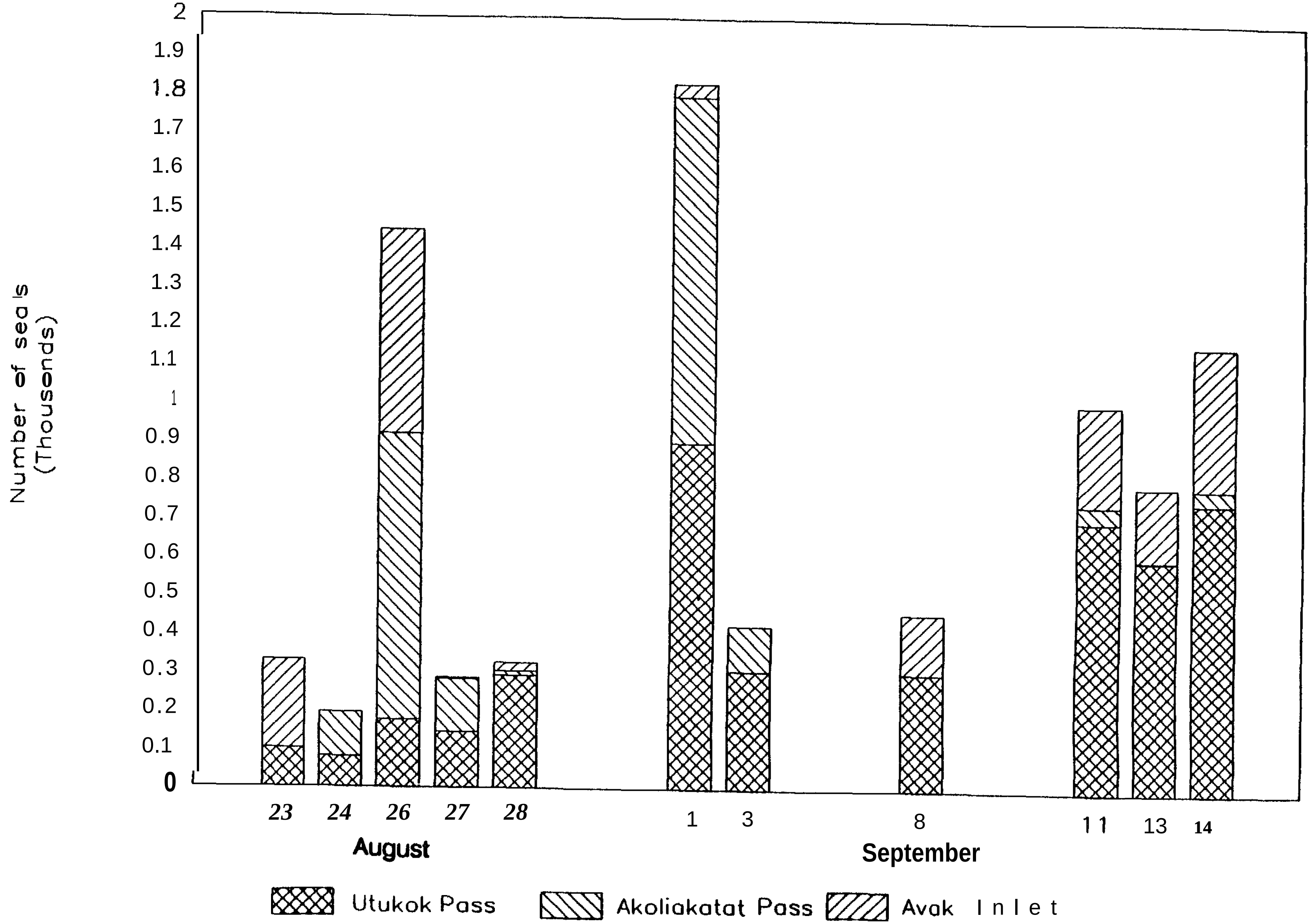

Figure 7. Numbers of spotted seals hauled out in the Kasegaluk Lagoon study area during August-September 1989.

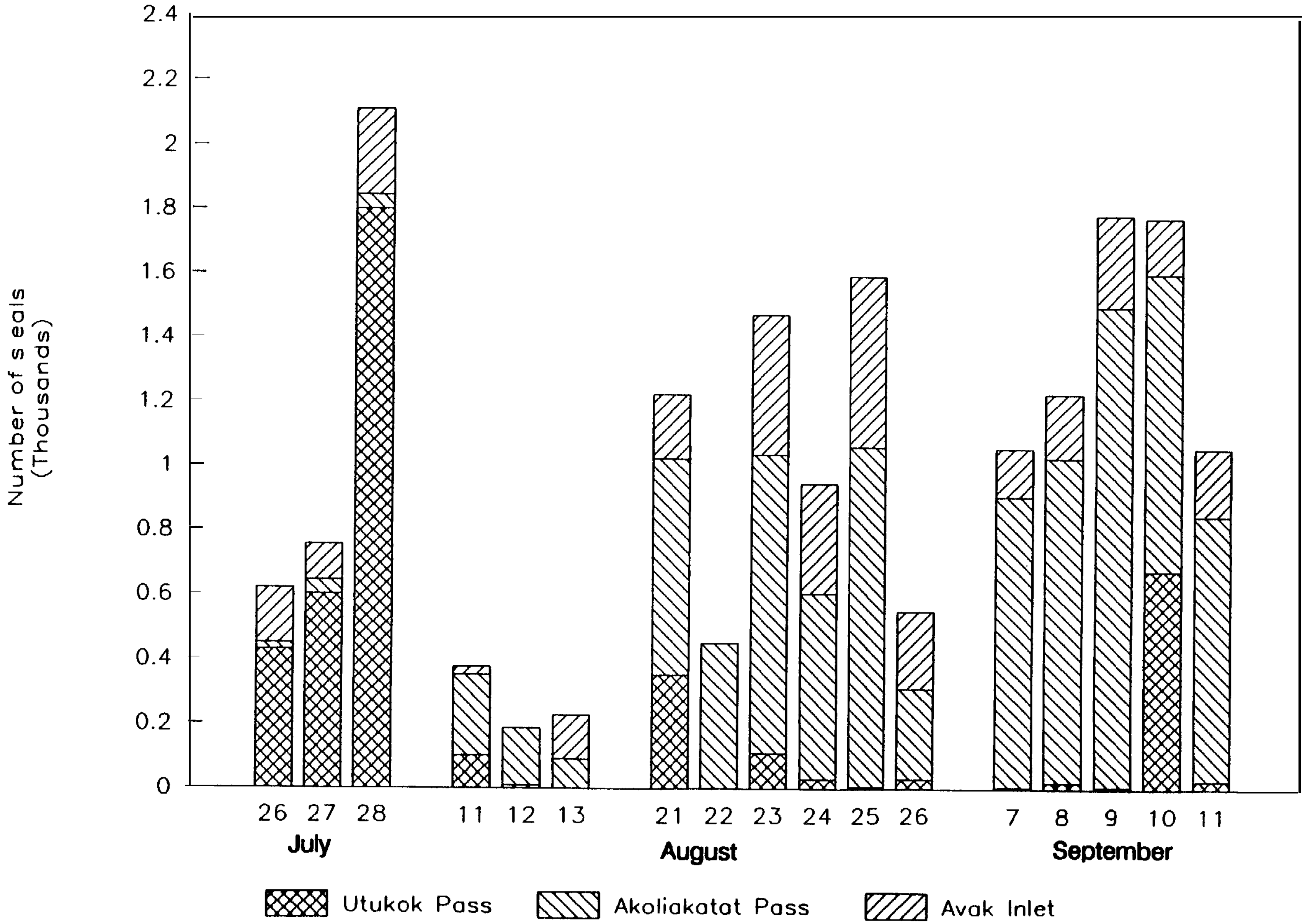

Figure 8. Numbers of spotted seals hauled out in the Kasegaluk Lagoon study area during July-September 1990.

Our survey data clearly indicate that spotted seals were still very abundant in Kasegaluk Lagoon in mid-September when our field season ended. Residents of Point Lay and Wainwright indicate that spotted seals are present in Kasegaluk Lagoon until freeze-up, well into October (Nelson 1982; Neakok et al. 1985; W. and D. Neakok personal communication). In October, 1989, at least 400 spotted seals were seen hauled out at Utukok Pass (A. Agnasagga personal communication) and in early October, 1990, over 200 were present at Akunik Pass (D. Ljungblad personal communication). During our July-September surveys we have never seen spotted seals hauled out at Akunik Pass, nor have we seen them hauled out at Naokok Pass at the south end of the lagoon. However, they are reported to be abundant near Naokok Pass just before freeze-up, sometimes hauling out on the newly formed lagoon ice (W. and D. Neakok personal communication). There is a site near here called Kasigialik which means "place where spotted seals remain."

Foods and Feeding

Following the period of reduced food intake and lower metabolic rate which occurs during the April-June molt (Ashwell-Erickson et al. 1986), spotted seals begin to feed intensively (Tikhomirov 1966). Throughout their range, they generally congregate after the molt at haulouts near an abundant food supply, especially near large runs of spawning fishes such as salmon, herring, capelin, or smelt or other locally abundant fishes such as arctic cod or sand lance (Ognev 1935; Tikhomirov 1966; Goltsev 1971; Frost et al. 1983; Bukhtiyarov et al. 1984).

There is very little direct information available on spotted seal feeding in the Kasegaluk Lagoon region. Ten seals were collected near Utukok and Akoliakatat passes in September 1981 (Lowry and Frost, unpublished). Nine of them had empty stomachs; the only one with food had eaten arctic cod. Point Lay hunters report that the seals eat fish, but not which kinds (W. Neakok personal communication). Wainwright hunters report that they eat Bering ciscos (*Coregonus laurettae*), as well as other fishes, when they are in the freshwater rivers of Avak Inlet and that they also sometimes have seaweed in their stomachs (Nelson 1982).

It is possible to speculate on which species spotted seals might be eating based on results of fish studies that have been done near Kasegaluk Lagoon, and what we know about spotted seal foods in other areas of Alaska. We have previously examined the contents of stomachs from 62 spotted seals collected in the Bering and Chukchi seas during July-September (Table 7). In all except a few, fish made up almost all of the contents. The species most often consumed were herring, saffron cod and sculpins. Also present were arctic cod, sand lance, smelt, capelin, flatfish, and salmon. All of these species except sand lance have been caught in and near Kasegaluk Lagoon.

Both local residents (Pedersen, in press) and fisheries studies (Craig and Schmidt 1985) report that smelt are present during June-September. Near Point Lay, peak abundance of smelt, which run up the rivers to spawn, occurs in about the third week of June. Following spawning the smelt return to the ocean, probably at about the time spotted seals arrive, and they are probably present along the coast during the rest of the year.

Herring are present in the Kasegaluk Lagoon area from late July until at least mid-September, with greatest numbers present after mid-August. They occur both inside the Lagoon and in nearshore and offshore marine waters (Craig and Schmidt 1985). In the southern Chukchi Sea herring was the major food of spotted seals near Shishmaref in July and October, and was eaten by seals in Kotzebue Sound in October (Lowry et al. 1981). It is likely that herring are also eaten by spotted seals in Kasegaluk Lagoon,

Arctic cod are widespread in northern Alaska and are a major forage species for birds and seals. They have been reported as food of spotted seals in the northern Bering Sea in spring, and in Kotzebue Sound and off Wainwright in summer (Lowry et al. 1981; Bukhtiyarov et al. 1984). Near Kasegaluk Lagoon arctic cod occur in marine and lagoon waters, and are sporadically abundant from late July until early September (Craig and Schmidt 1985). Lowry and Frost (unpublished) caught arctic cod in an otter trawl near Utukok Pass in September 1981, and arctic cod were present in the stomach of a seal collected there.

Considering the above information, we think it is likely that spotted seals in the Kasegaluk Lagoon area are feeding primarily on herring, capelin, smelt, arctic cod, and sculpins and probably to a lesser degree on salmon, arctic flounder, and saffron cod. Invertebrates may also be important prey, particularly shrimps. Crangonid shrimps are very abundant in sandy nearshore areas of the southern Chukchi Sea and maybe abundant off Kasegaluk Lagoon. They were present in large amounts in a few spotted seal stomachs from Shishmaref in July and were also found in stomachs of seals collected in Kotzebue Sound in August and September (Table 7).

Table 7. Stomach contents of spotted seals from the northern Bering and Chukchi seas, July-December, 1966-1987. Data are from Lowry et al. (1981), Frost and Lowry (1989), and ADF&G unpublished. Values for invertebrates and total fish are pereent of total volume. Values for individual fish species are percent of the total number of identifiable fishes. P. indicates that the item was present, but the number could not be determined.

Prey	July				August	
	Gol 1981 n=1	Shi 1976 n=3	Shi 1977 n=10	Wai 1975 n=1	woo 1 1972 n=1	Wai 1975 n=l
Amphipods		<1			<1	<1
Mysids						<1
Shrimp			1	26		
Fam. Crangonidae		87	<1		<1	
Other Invertebrates						1
TOTAL INVERTEBRATES	o	87	1	26	4	2
TOTAL FISHES	100	13	99	74	96	98
Sculpins						100
Saffron cod		38	4	P	92	
Arctic cod				P		
Herring			96			8
Flatfish		62				
Salmon	100					
MEAN VOLUME (ml)	1670	403	632	7	76	17

Abbreviations for locations are as follows: Gol=Golovin; Shi=Shishmaref; Wai=Wainwright; Wool=Cape Wooley; Tel= Teller; Esp=Espenberg;Akol=Akoliakatat;Utuk=Utukok;Gam=Gambell; Kotz=Kotzebue Sound.

Table 7. (cent'd)

Prey	September					October					
	wool 1971 n=1	Te 1 1970 n=1	Esp 1981 n=1	Akol 1981 n=2	Utuk 1981 n=1	Go 1 1981 n=5	Gam 1966 n=1	Tel 1970 n=2	Tel 1972 n=3	Shi 1977 n=14	Kotz 1987 n=3
Amphipods										<1	
Crabs							7				
Shrimp						<1				<1	<1
Other Invertebrates							7				
TOTAL INVERTEBRATES	0	0	0	0	0	<1	14	0	0	1	6
TOTAL FISHES	100	100	100	100	100	100	86	100	100	99	94
Sculpins				7	100		100				
Saffron cod	98		100			100				17	64
Arctic cod				93							31
Herring		33						100	95	83	5
Sand lance	2										
Rainbow smelt									5		
Capelin		67									
MEAN VOLUME	24	530	<1	13	<1	513	112	1470	1793	433	8

Abbreviations for locations are as follows: Gol=Golovin; Wai=Wainwright; Shi=Shishmaref; Wool=Cape Wooley; Tel=Teller; Esp=Espenberg; Akol=Akoliakatat; Utuk=Utukok; Gam=Gambell; Kotz=Kotzebue Sound.

Table 7. (cent'd)

	November							December	
	Te 1 1966 n=l	Tel 1972 n=2	Nome 1966 n=2	Nome 1976 n=1	Nome 1980 n= 1	Shi 1977 n=1	Esp 1984 n=1	Nome 1966 n= 1	Nome 1980 n=l
Shrimp									
Fare. Crangonidae							9		
TOTAL INVERTEBRATES	0	0	0	0	0	0	9	0	0
TOTAL FISHES	100	100	100	100	100	100	91	100	100
Sculpins			P	<1			37	50	
Saffron cod	12	24	P	<1	22		8		
Arctic cod					22	100			100
Herring								50	
Sand lance				99	51				
Flatfish							55		
Rainbow smelt	88	76							
Other Fishes					5				
MEAN VOLUME	200	965	400	867	915	751	88	175	<1

Abbreviations for locations are as follows: Gol=Golovin; Wai=Wainwright; Shi=Shishmaref; Wool=Cape Wooley; Tel=Teller; Esp=Espenberg; Akol=Akoliakatat; Utuk=Utukok; Gam=Gambell; Kotz=Kotzebue Sound.

There are no estimates of the size of fish stocks in the Kasegaluk Lagoon region. However, the large number of seals hauling out there from July until at least October suggests that the fish biomass must be substantial. Ashwell-Erickson and Elsner (1981) calculated that spotted seals eat about 1.7 kg/day of a diet of primarily fish. Applying this estimate to the maximum count of seals hauled out at Kasegaluk Lagoon (2,100) would result in a consumption of about 3,570 kg of food/day, 107,000 kg/month, or over 400,000 kg in a 4 month period. This is only a minimum estimate since the total number of seals in the area, as opposed to the number hauled out, is unknown. The actual degree to which seals are feeding in this area is also unknown. Ashwell-Erickson and Elsner (1981) found that metabolism and fat levels in captive spotted seals were lowest in May-July, somewhat higher in August and September, and highest in October-April. Tikhomirov (1966) indicated that intense feeding occurred in July, following the molt, and that seals remained in areas of high fish abundance despite predation by bears and disturbance by humans. It is common knowledge among hunters that seals sink when they first arrive in July and early August, but that by late August or early September they have put on fat and float when shot. Without telemetry studies to document haulout patterns, movements, and diving behavior it will not be possible to determine the degree to which spotted seals are feeding in and near Kasegaluk Lagoon.

Responses to Disturbance

Based on our observations at Kasegaluk Lagoon during 1989 and 1990, the spotted seals there are the most wary of any seals that we have worked on. Principal investigators of this project have surveyed harbor seals on coastal haulouts, and spotted, ringed, ribbon (*Phoca fasciata*), and bearded (*Erignathus barbatus*) seals and walruses (*Odobenus rosmarus*) on the ice. Of these, harbor seals on coastal haulouts have been the most easily disturbed. Nonetheless, it has usually been possible to fly over groups of hauled out harbor seals at 150-300 m with no visible response. In our Kasegaluk Lagoon surveys, evenat914 m spotted seals sometimes went into the water when the aircraft was more than 1 km away. At altitudes below 500 m it was almost impossible to fly over large groups of seals without causing some or all of them to go into the water. Often, however, after an initial “wave” of seals closest to the waterline went in, the rest would remain hauled out.

Although seals in Kasegaluk Lagoon were more likely to flee into the water in response to aircraft noise than harbor seals, they also hauled back out more readily. It has been our experience with harbor seals in Prince William Sound that once seals are disturbed and leave a haulout they may not return until the next tidal cycle. In contrast, on several occasions at Utukok and Akoliakatat passes, counts of seals on surveys flown only a few hours apart indicated the same number of seals, even though almost all of the seals had gone into the water on the first flight. This behavior was confirmed by the field camp observations made at Avak Inlet.

We do not know why spotted seals at Kasegaluk Lagoon respond so readily to aircraft. To our knowledge, aircraft do not regularly land on or near seal haulouts, nor do they intentionally fly over or otherwise harass the seals. The low lying coastal topography should not amplify sounds, neither does it provide any relief that would reduce or block aircraft noise. The area does experience frequent low altitude aircraft traffic. Commuter airlines flying between Barrow, Wainwright, and Point Lay fly over Kasegaluk Lagoon several times a day when weather permits. On days following stormy weather that precludes flying, six or more planes may land at Point Lay, which may represent 10 or more flights over the seal haulouts. The most commonly used flight path passes almost directly over haulouts at Akoliakatat Pass and Avak Inlet; aircraft traffic is less likely to pass over Utukok Pass. The rapid re-hauling behavior of spotted seals may be an accommodation to the frequent disturbances that result.

Residents of Point Lay confirm that spotted seals are very responsive to disturbance, noting that "they won't stay anyplace where there are people around, they'll go someplace else" (Neakok et al. 1985). Spotted seals in other regions are similarly responsive. In the Sea of Okhotsk, Tikhomirov (1966) described their response to danger as 'similar to an avalanche". He considered spotted seals to be the most cautious of all pinnipeds.

In the Kasegaluk Lagoon region, spotted seals may sometimes be disturbed on their haulouts by grizzly bears (Ursus arctos). On many of the days when we flew surveys, we saw one or more bears on the barrier islands near Akoliakatat and Utukok passes. Disturbance by humans in boats or on land probably is not common. Akoliakatat Pass and Avak Inlet are quite far from both Wainwright and Point Lay. Point Lay hunters seldom travel beyond Icy Cape (Warren Neakok, personal communication). Waterfowl and caribou (Rangifer tarandus) hunting sometimes occur near Utukok Pass. In recent years spotted seals are hunted by only a few residents of Point Lay, since the meat is no longer needed for dog food and the hides cannot be sold. (W. Neakok personal communication). The limited human activity that occurs near major haulouts does not seem to explain the extremely wary behavior of seals in the area.

SUMMARY AND CONCLUSIONS

This report describes the distribution, relative abundance, and habitat use of spotted seals (Phoca largha) and beluga whales (Delphinapterus leucas) in the Kasegaluk Lagoon region of the Chukchi Sea. Data from previous studies are reviewed and results from surveys conducted in 1989-90 are presented.

Beluga whales and spotted seals are abundant in the Kasegaluk region of the northeastern Chukchi Sea during summer and autumn. Belugas feed, calve, and probably molt in nearshore waters during early summer. Spotted seals haul out in large numbers on spits and sandbars near passes from July until freeze-up. Belugas are hunted by coastal residents, and in some years make up over 50% of the annual harvest of wild foods in the village of Point Lay.

Prior to 1989, there had been no systematic studies of the distribution and abundance of belugas or spotted seals in the Kasegaluk Lagoon region. In 1989, the Minerals Management Service funded the Alaska Department of Fish and Game, under subcontract to LGL Ecological Research Consultants, Inc., to investigate the use of Kasegaluk Lagoon by spotted seals and beluga whales by conducting aerial surveys in the nearshore zone at intervals between July and September. The information presented in this report is the product of cooperation among the Alaska Department of Fish and Game, the North Slope Borough, LGL, and the people of Point Lay.

Aerial surveys for belugas were flown using a high-wing Aero Commander Shrike. Surveys were conducted at 305 m altitude along a flight track that followed the coastline from the north end of the lagoon to the mouth of the Pitmigea River, 0.9 km off shore. On the return north, the aircraft flew along a series of transects 5-9 km off shore. Each observer looked for and counted belugas within a 0.9 km wide strip. Visual counts were supplemented by aerial photographs.

Surveys for spotted seals were conducted from a Cessna 206 on floats. The aircraft flew along the coastline about 0.5 km offshore at altitudes ranging from 150-914 m. Survey periods of approximately seven days were selected at intervals from July to mid-September. A single observer counted seals with binoculars and, when possible, took photographs of large groups.

Information on beluga whales harvested by people of Point Lay was compiled from data provided by the North Slope Borough Department of Wildlife Management and from unpublished records of the Alaska Department of Fish and Game. This included data on the magnitude of the harvest from 1977-1990, and results of stomach contents analyses. Other investigations of spotted seals as part of this project included a field camp to observe haulout behavior and a compilation of data on summer-autumn food habits data.

Beluga whale surveys were flown on 12 consecutive days from July 3-14, 1990. Belugas where seen during every flight with numbers ranging from 31 to 1200. The largest sightings were on July 3-6, when a group of 800-1200 was seen in the southern portion of the study area, off Omalik Lagoon. After July 6, the number of belugas seen near Omalik Lagoon decreased markedly, and whales began to appear at passes along Kasegaluk Lagoon. They were first seen at the southernmost passes, and later to the north of Point Lay. From July 7-14 a maximum of 242 belugas was seen on any one day. No surveys were conducted from July 15-25. No belugas were seen on periodic spotted seal surveys after July 25.

The beluga harvest in Point Lay usually occurs in early July. Since 1977 the average annual harvest has been 22, with a range of O-64. The average harvest has increased as follows: 10 for the period 1977-1980; 19 for 1981-1985; and 35 for 1986-1990.

Stomachs of belugas harvested by Point Lay hunters were all empty in 3 of the 4 years since 1987, probably because of the long drives that preceded the hunts. In 1988, 11 of 21 stomachs had measurable contents which consisted almost entirely of crangonid shrimps and echiuroid worms. These prey indicated that belugas were feeding on the bottom.

The reasons why belugas concentrate near Kasegaluk Lagoon are unknown, but may include calving, molting, and/or feeding. Births and females with neonate calves have been observed in the large concentration of belugas that occurs in the region. Large gravel beds are located off southern Kasegaluk Lagoon, and belugas may go to those areas to rub off loose skin during the molting process. Some feeding occurs near Kasegaluk Lagoon, as demonstrated by the presence of food in the stomachs of harvested whales and reports from hunters. However, the importance of this region for feeding is unknown. Based on fisheries studies and local residents there is no indication that nearshore food resources are so abundant or suitable that they would attract and feed over 1,000 belugas for several weeks. Most suitable species of forage fishes are not abundant until after the belugas have gone.

Spotted seal surveys were flown during two periods in 1989 (August 23-38 and September 11-14) and four periods in 1990 (July 26-28, August 11-13, August 21-26, and

September 8-12). Seals were observed hauled out at three general locations: Utukok Pass and associated shoals; Akoliakatat Pass and the spits to the east and west; and Avak Inlet on spits within the Inlet. No seals were seen hauled out during the July 3-14, 1990 beluga surveys. By late July, 500-2000 seals were hauled out, primarily at Utukok Pass. In 1990 use of Utukok Pass was greatest in late July and early August, decreased markedly in late August, and increased again in early September. Late August and September 1989 surveys suggested the' same trend. Over 400 seals were reported hauled out at Utukok Pass in early October 1989, well after our surveys had ended.

At Akoliakatat Pass in 1989 the highest numbers of seals counted on the three haulout sites combined were 740 on August 26 and over 900 on September 1. In 1990 few seals (less than 250) were counted at Akoliakatat Pass until the third week in August. From then until mid-September there were usually 500-1500 seals hauled out.

In Avak Inlet the maximum number of seals counted at the four haulout sites was 530 on August 26, 1989 and 532 on August 25, 1990. In 1990 use of this area was greater in late August than in either July or September.

These three locations in Kasegaluk Lagoon are the largest systematically documented and verified spotted seal haulouts in Alaska, with 1,800-2,100 seals counted in the area in July-September 1989 and 1990. Available reports from 1974-1981 suggest that a similar number of seals used the area 10-15 years ago. Only three other areas in Alaska are reported to have 1,000 or more spotted seals hauled out (Kuskokwim River mouth, Scammon Bay, and Cape Espenberg); those sightings are more than 10 years old, and none of the numbers have been from verifiable surveys or photographs.

While there is little direct information available on spotted seal feeding in or near Kasegaluk Lagoon, it is likely that seals concentrate there to feed. They arrive in late July, following a period of reduced food intake during the April-June molt. During this time metabolic rates increase significantly and the seals gain weight. A compilation of stomach contents data from 62 spotted seals collected along the Bering and Chukchi Sea coasts in summer-autumn 1966-1987 indicates that the most commonly eaten foods are herring, saffron cod, arctic cod, sculpins, smelt, flatfish, and capelin. All these types of fishes are present inside or off shore of Kasegaluk Lagoon. The species most likely to be used as food by spotted seals in this area are herring, capelin, smelt, and arctic cod. Calculations based on energetic studies suggest that spotted seals hauled out at Kasegaluk Lagoon consume at least 3,570 kg of food per day, which is over 400,000 kg of food in a four month period.

The spotted seals at Kasegaluk Lagoon are the most wary of any seals that we have studied. As aircraft approached at altitudes of up to 914 m and distances of 1-2 km, seals sometimes left the haulouts and went into the water. At altitudes below 500 m it was almost impossible to fly over a large group without causing some or all of them to go into the water. However, seals generally hauled back out relatively quickly after being disturbed which may be an accommodation to the frequent aircraft traffic in the area.

At this point, one complete season of surveys has been conducted for belugas and spotted seals, and another partial season for seals only. While aerial surveys have confirmed that Kasegaluk Lagoon is one of the most important concentration areas for spotted seals in Alaska, they do not provide information on why the area is important, or on specific aspects of haulout behavior, movements, and feeding.

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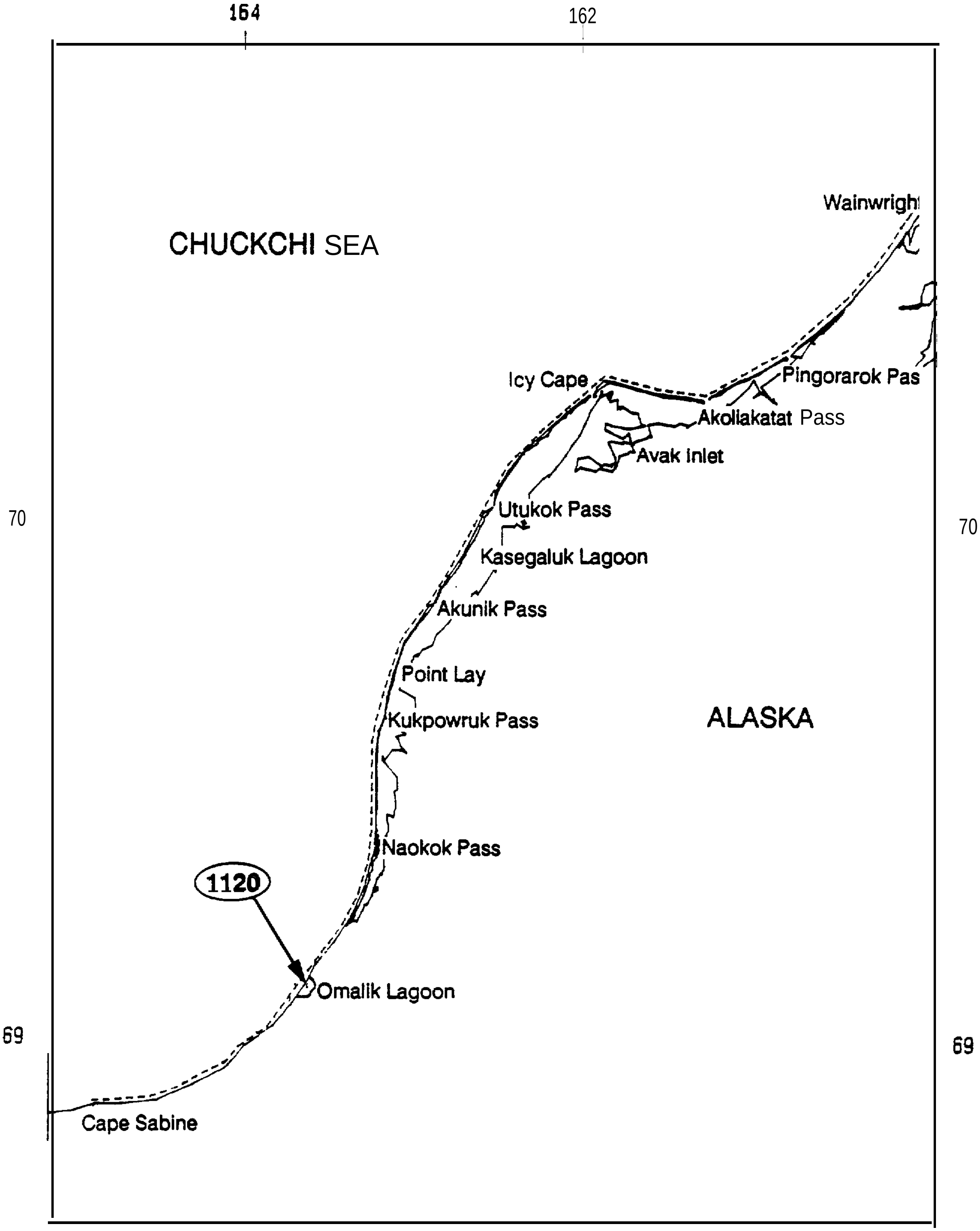
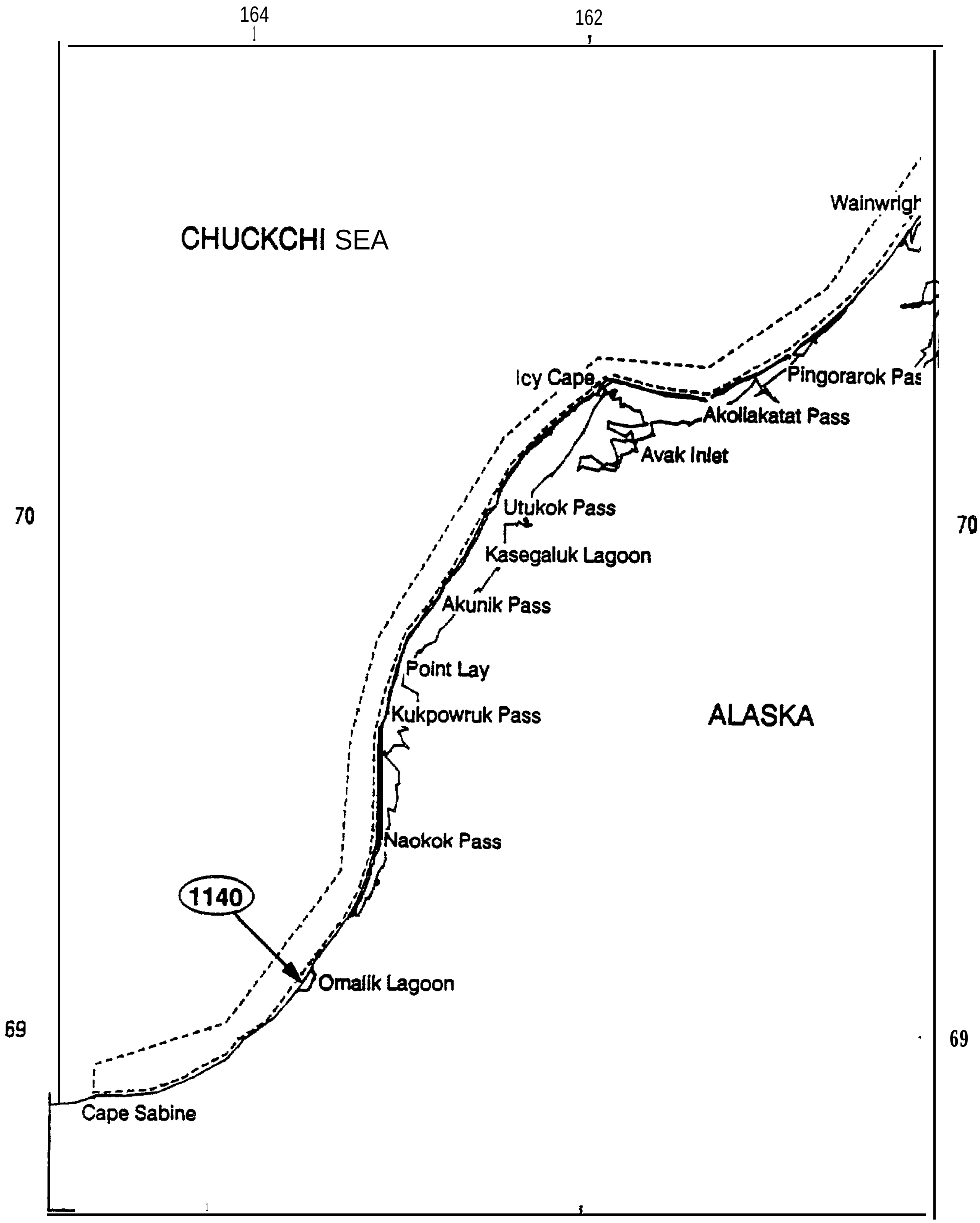
APPENDIX A

FLIGHT LINES AND SIGHTINGS FROM AERIAL SURVEYS FOR BELUGA WHALES IN THE KASEGALUK LAGOON REG1ON, 3-14 JULY 1990

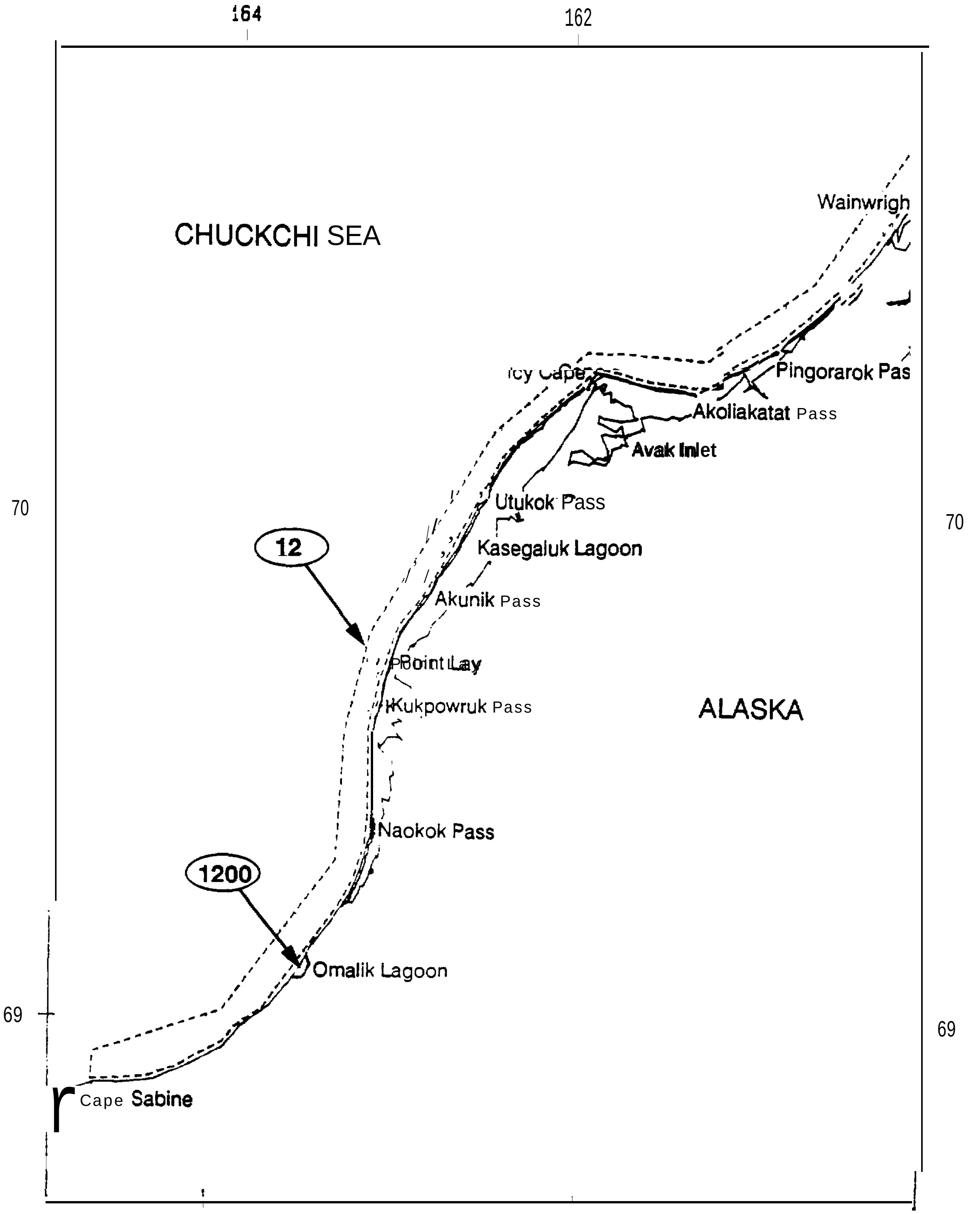


Flight lines and sightings of belugas for 3 July, 1990.

Appendix A2

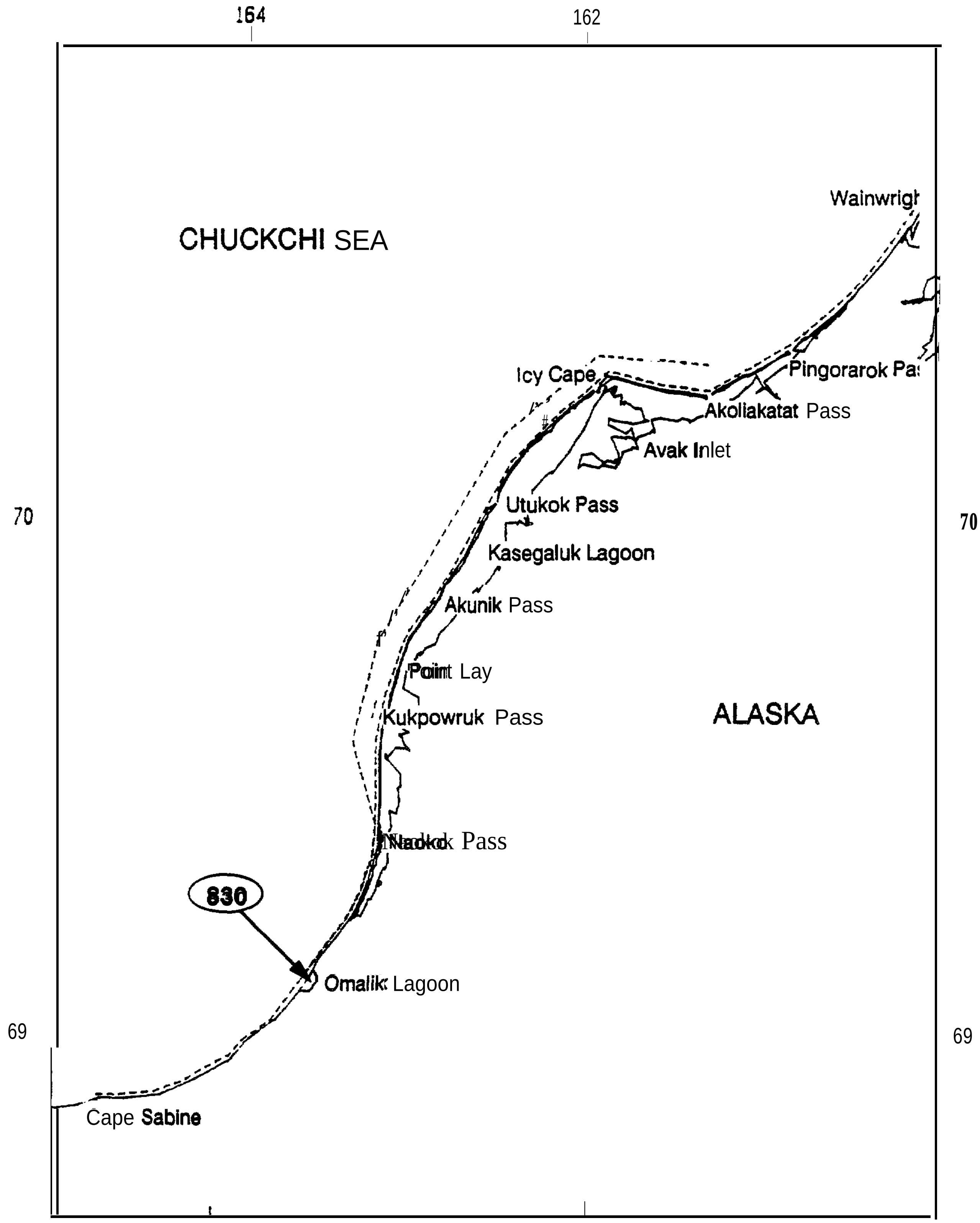


Flight lines and sightings of belugas for 4 July, 1990.

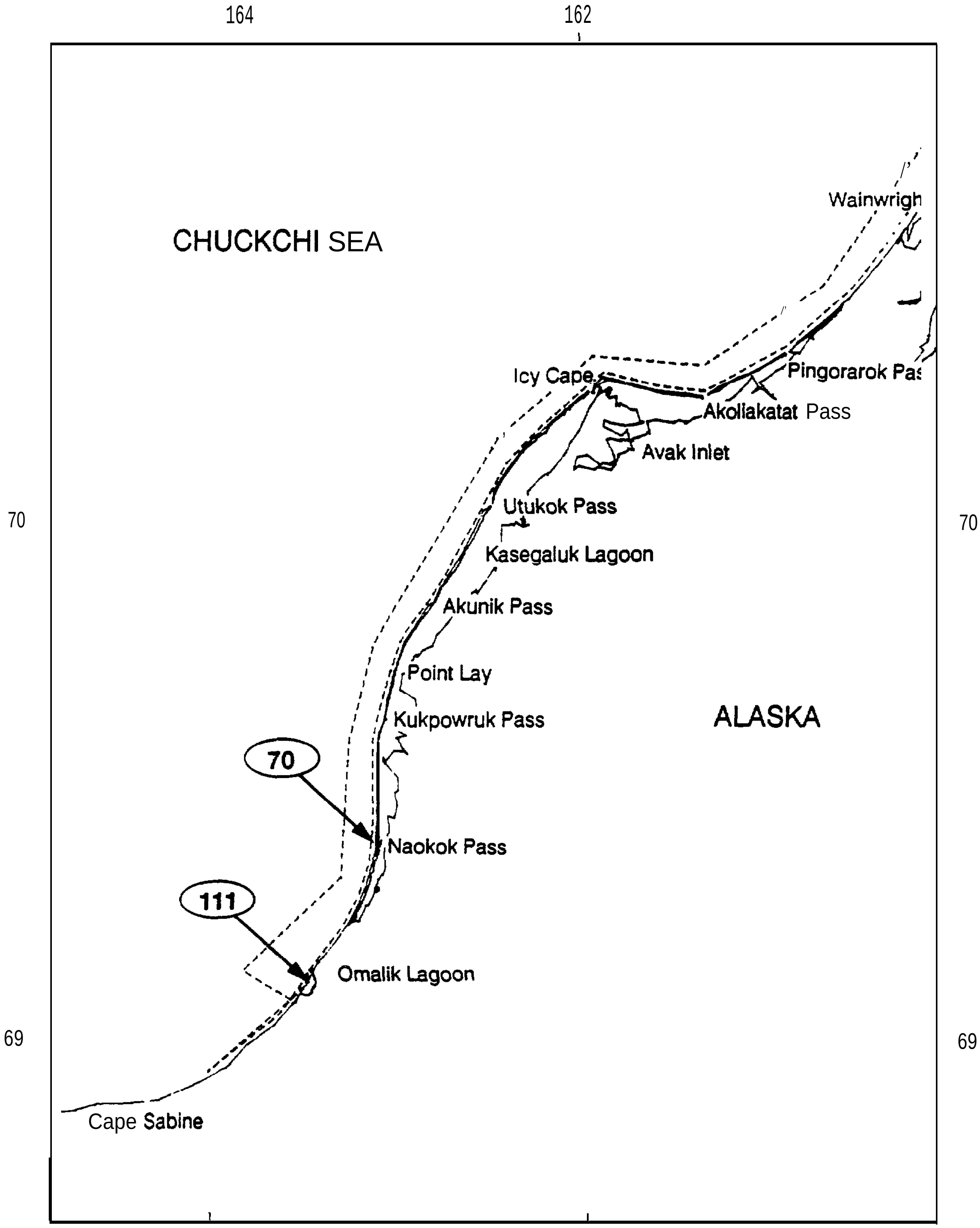


Flight lines and sightings of belugas for 5 July, 1990.

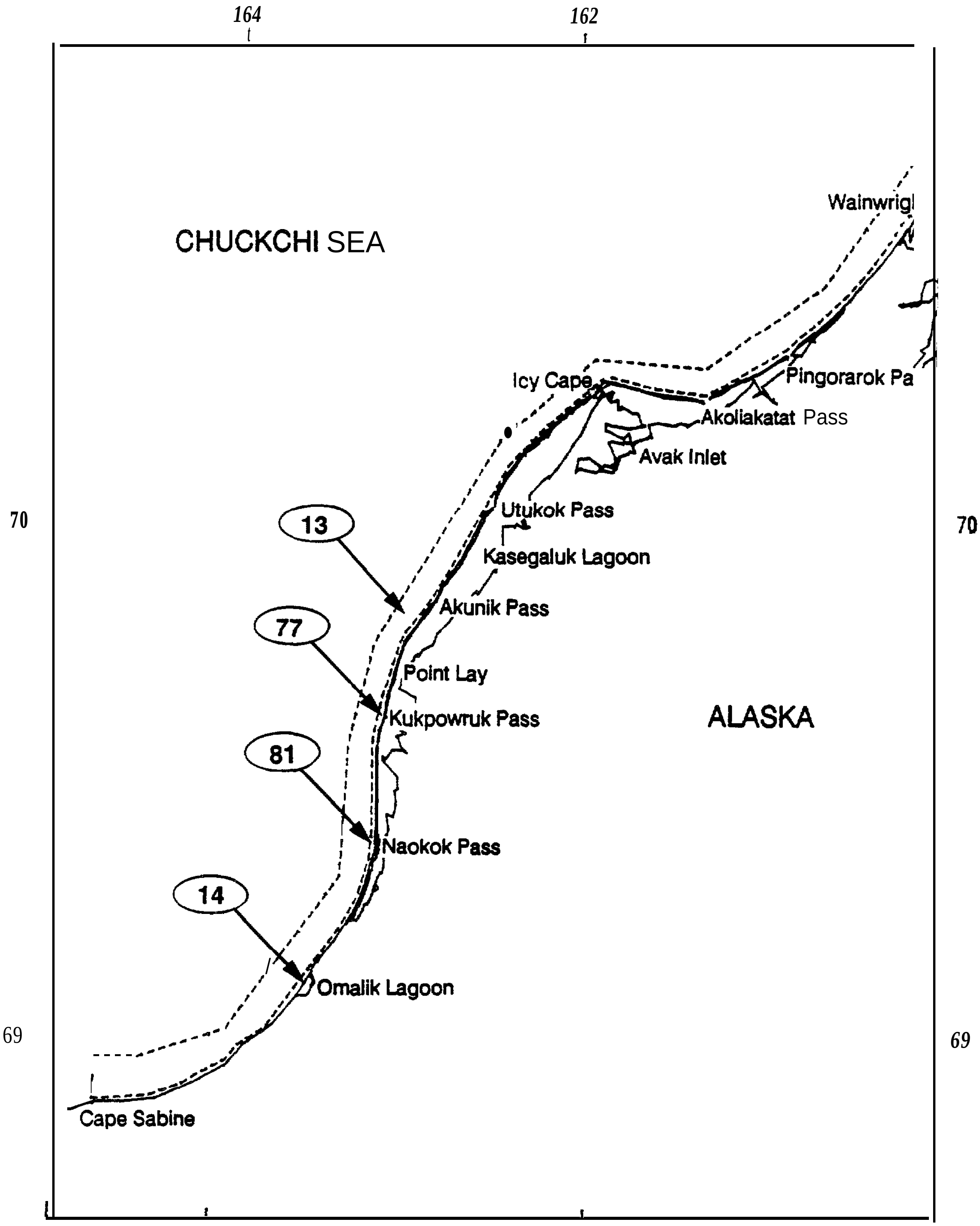
Appendix A4



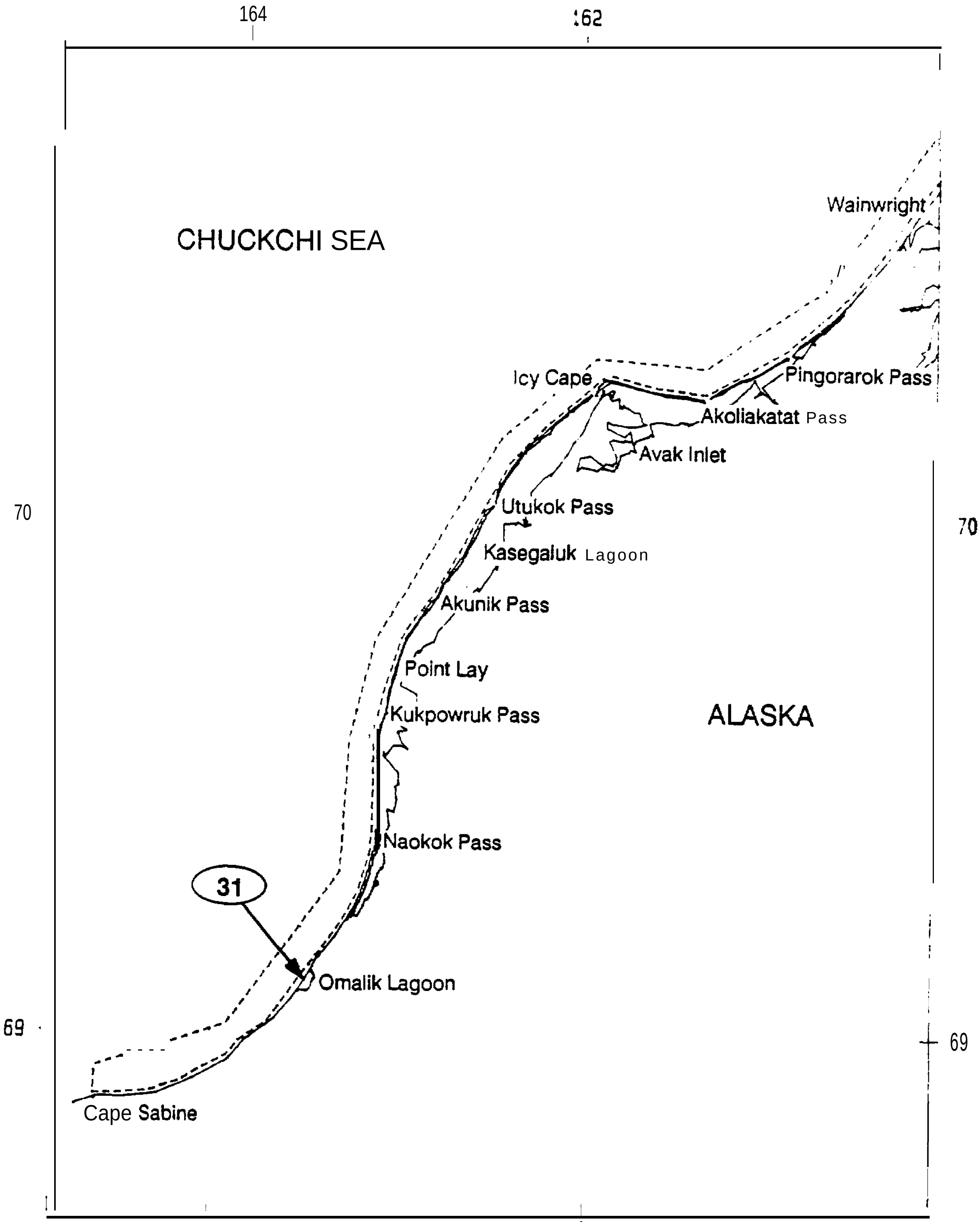
Flight lines and sightings of belugas for 6 July, 1990.



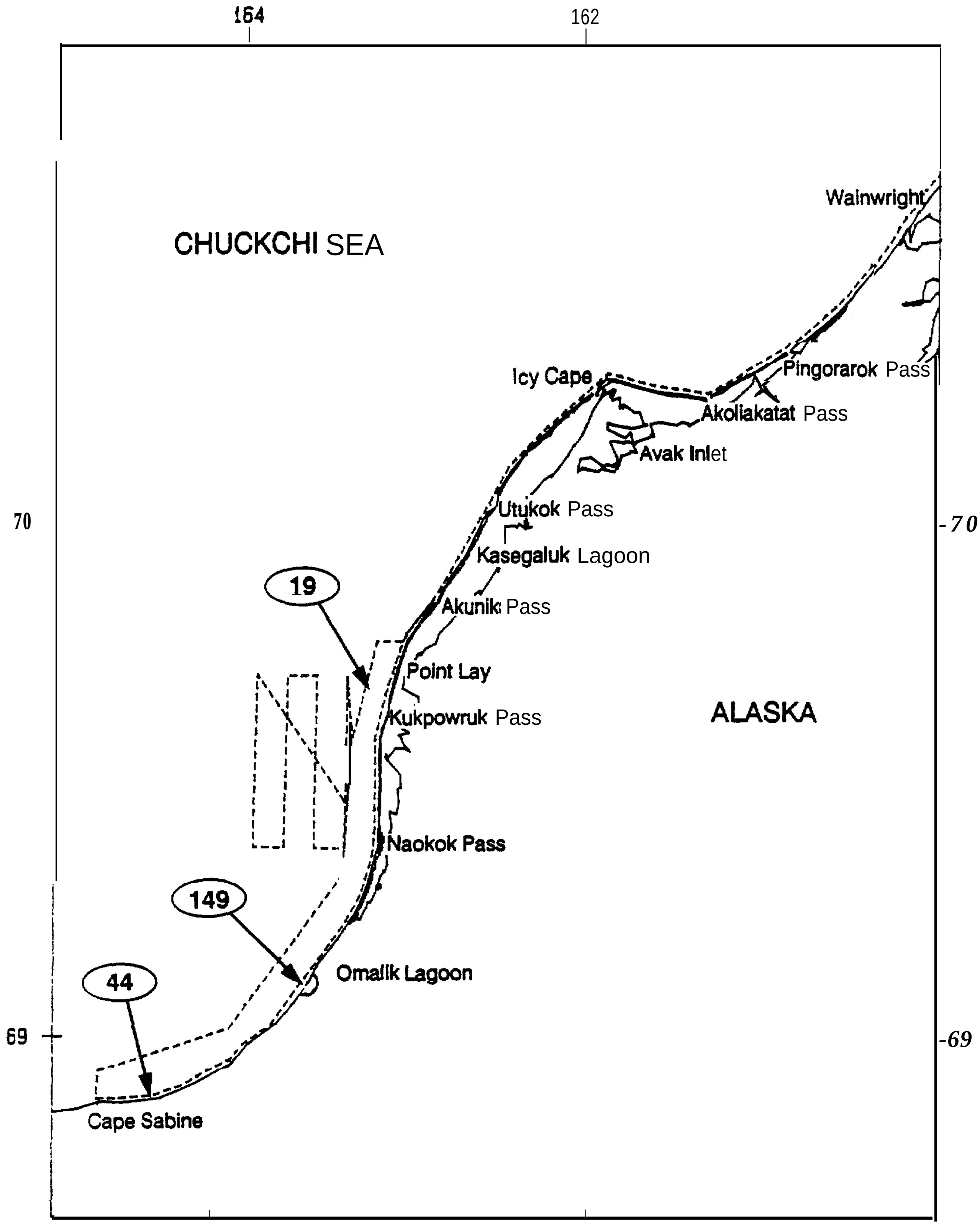
Flight lines and sightings of belugas for 7 July, 1990.



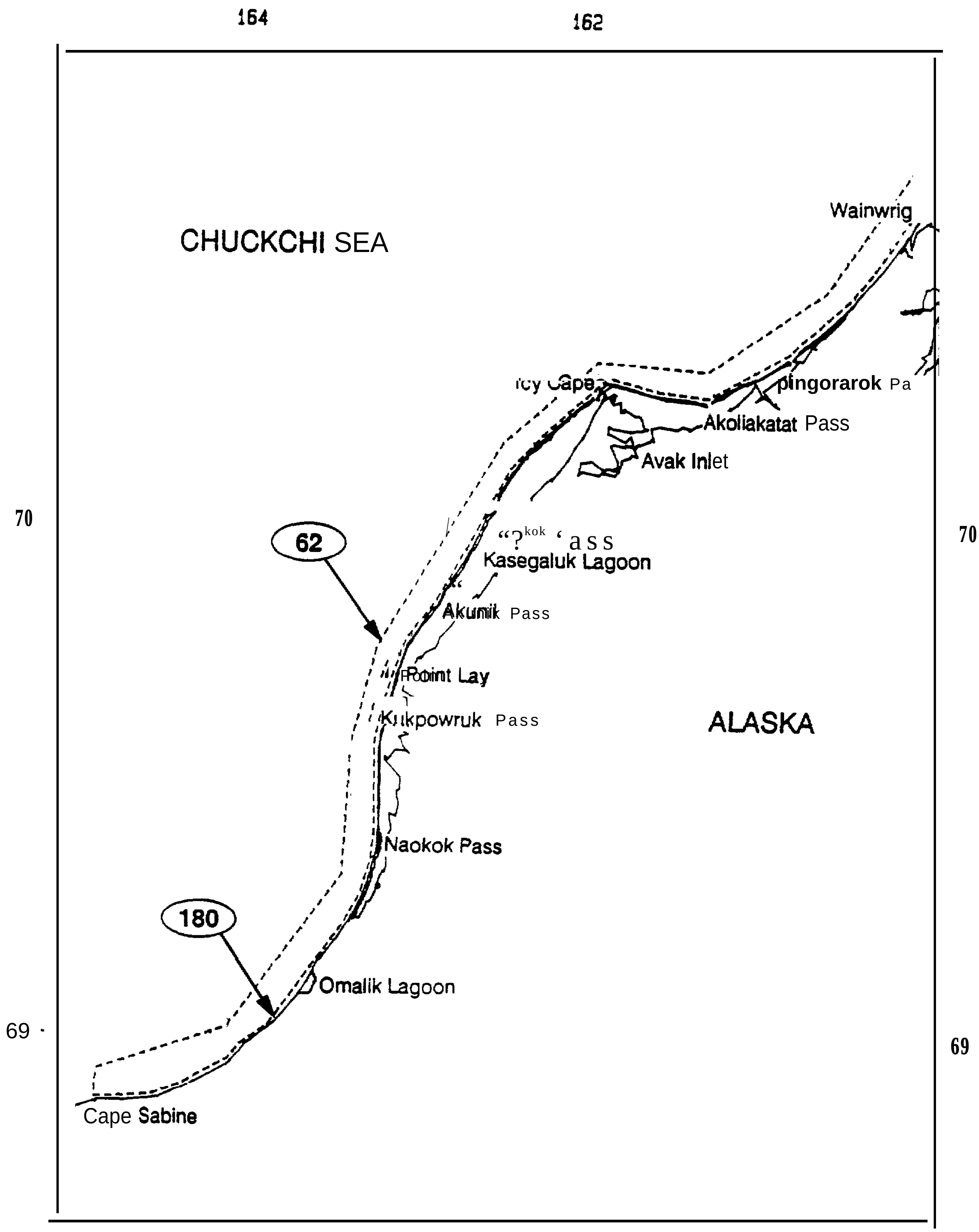
Flight lines and sightings of **belugas** for 8 July, 1990.



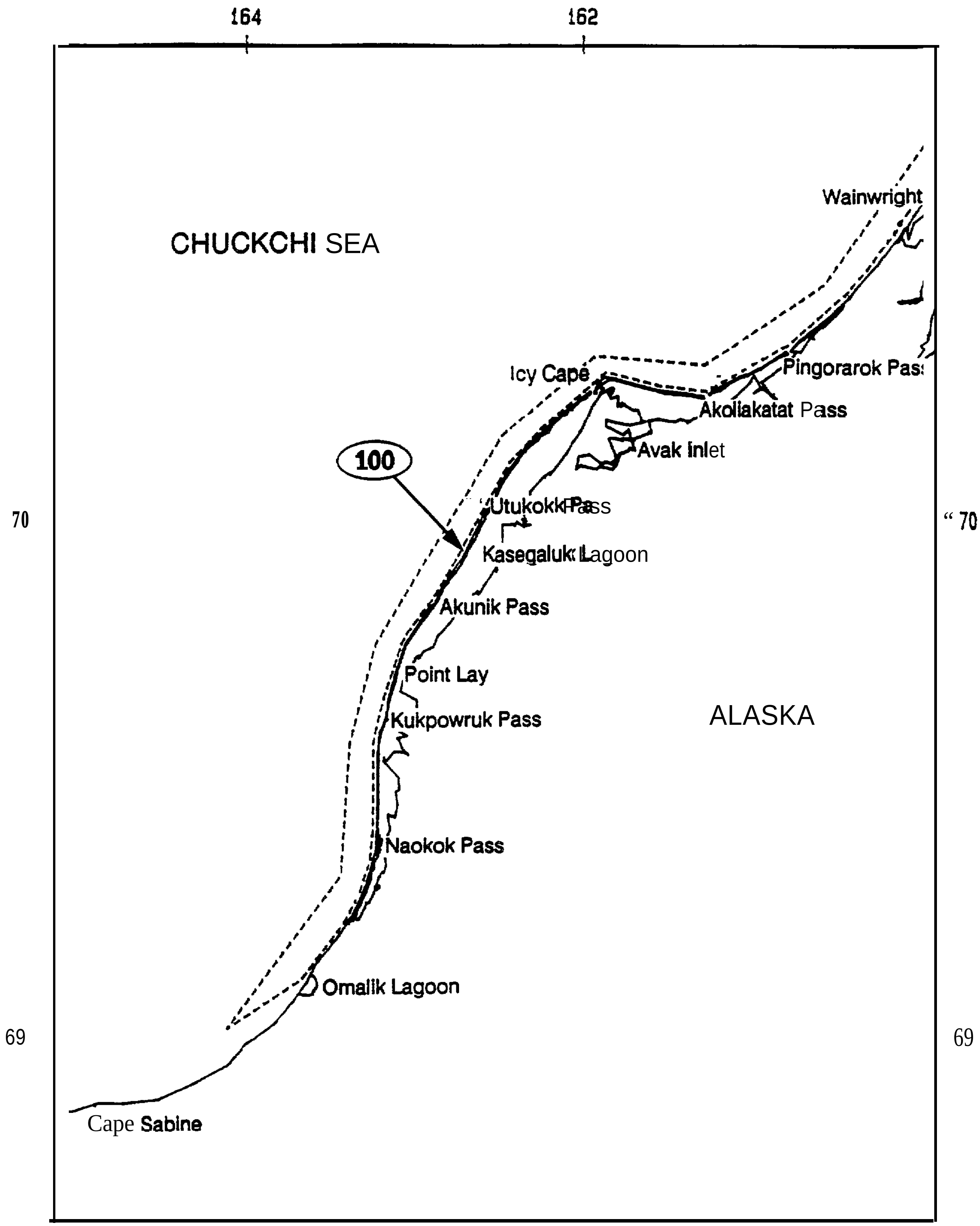
Flight lines and sightings of belugas for 9 July, 1990.



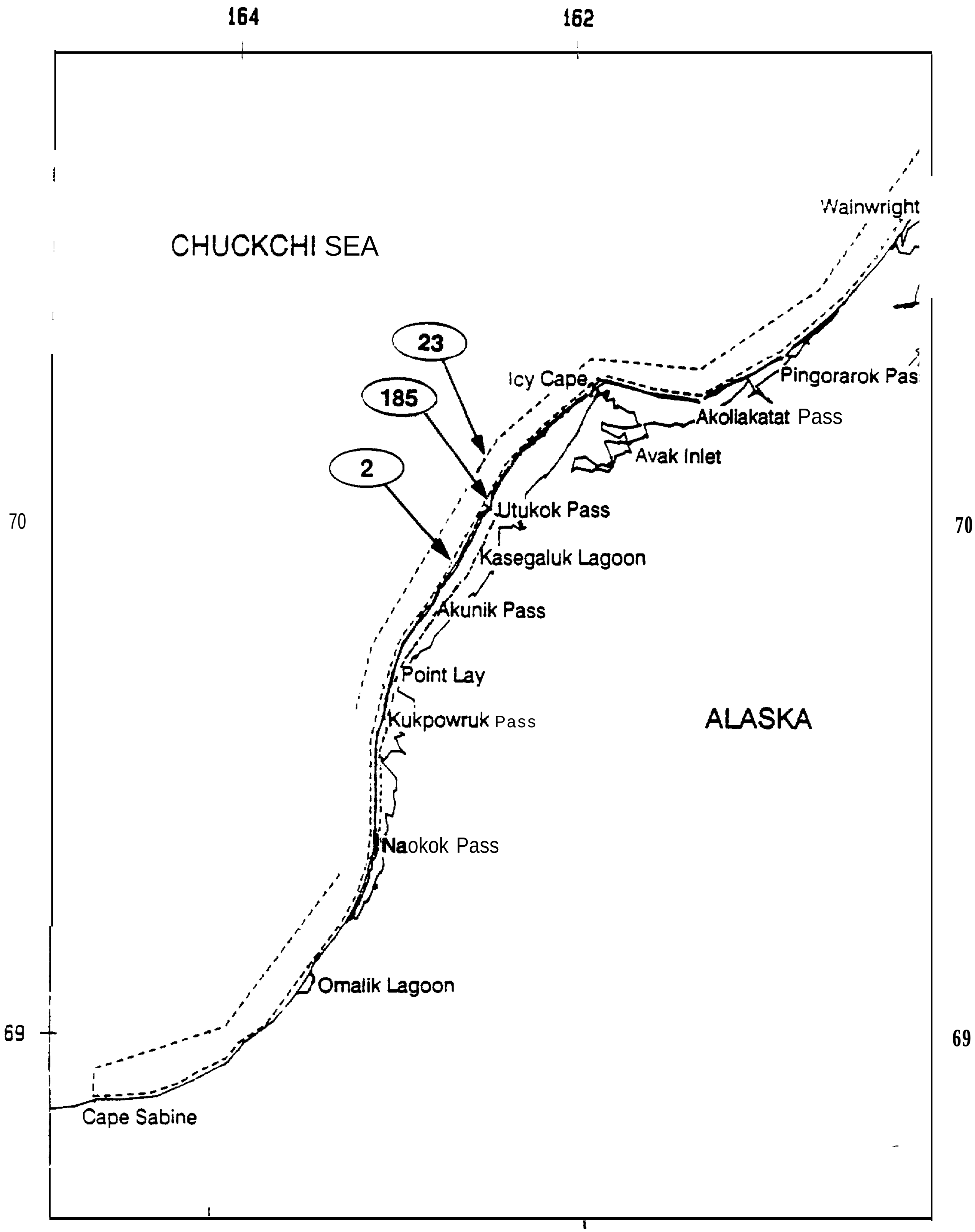
Flight lines and sightings of belugas for 10 July, 1990.



Flight *lines* and sightings of belugas for 11 July, 1990.

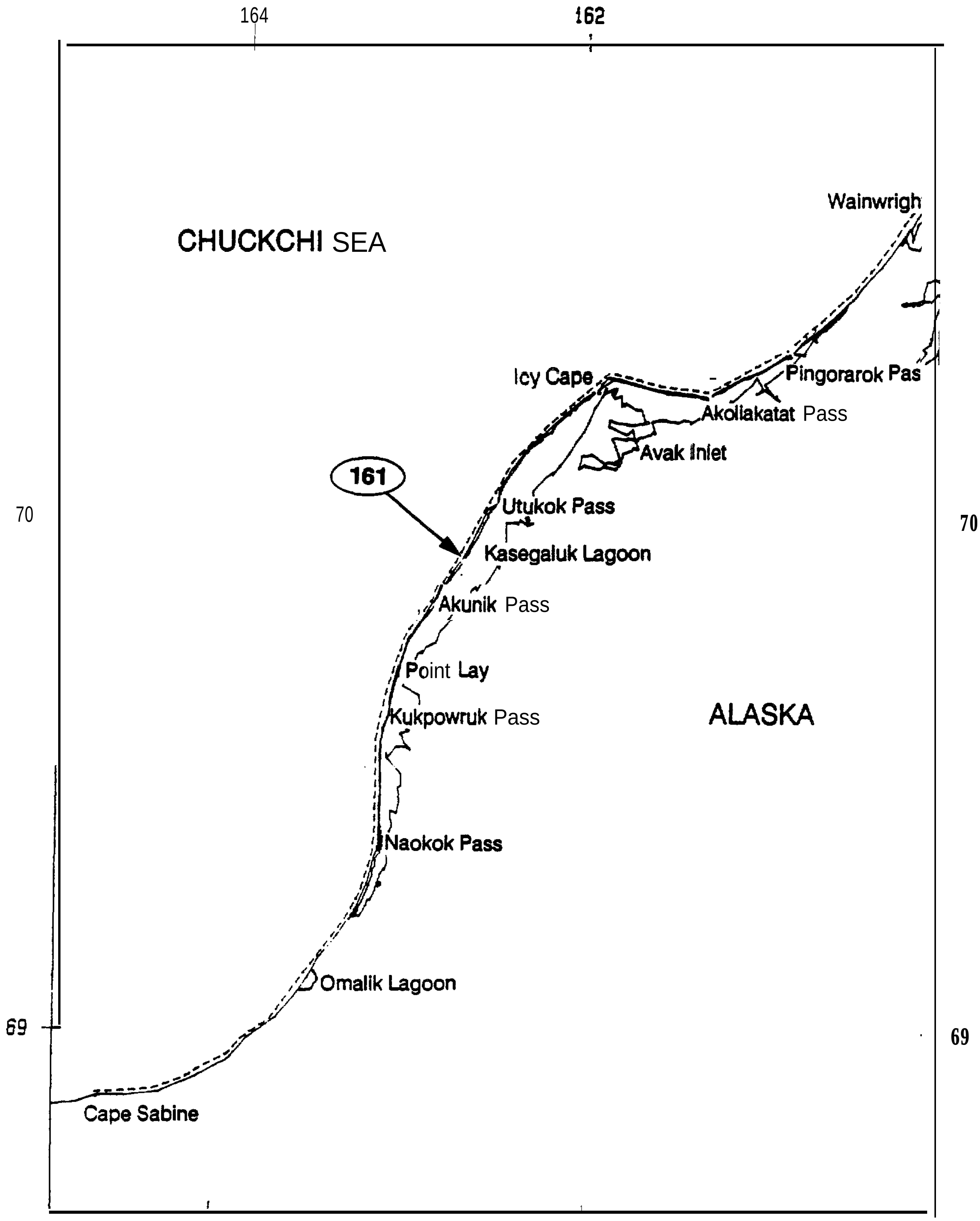


Flight lines and sightings of belugas for 12 July, 1990.



Flight lines and sightings of belugas for 13 July, 1990.

Appendix A12



Flight lines and sightings of **belugas** for 14 July, 1990.

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